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ASSESSMENT OF VALUE ADDITIONS IN AFFORESTATION WORKS

S. PAUL RAJ*

Introduction

Afforestation does not merely mean planting tree seedlings in a given area. It also includes many other activities such as soil conservation works, moisture conservation works etc. Thus, any afforestation programme not only adds vegetative cover but also adds several other values. However, generally, the success of any afforestation works in the Forest Department is judged based on the survival percentage of the planted seedlings alone. On the other hand, many values added as a result of afforestation activities are not taken into consideration for evaluating the success of afforestation. If we do not take into consideration these values also, our assessment could lead to a wrong conclusion. These values may differ depending upon the objectives of the respective afforestation programmes. The objectives of afforestation works in a wildlife sanctuary would be different from that of a watershed. Thus, the value added in these two places would be different depending upon the site and the objectives. A recent study made by the Tata Energy Research Institute on the impact of afforestation works in Haryana, listed many impacts such as soil amelioration, water yield, leaf litter deposition along with tree stocking (Dhar, 1994). The assessment of ecological benefits is also attempted by Kaul *et al.* (1965). It substantiates that any afforestation programmes should be judged by all such benefits. In this paper, it is proposed to list all benefits/values of afforestation programmes and to prioritize these values depending upon the objectives of the programmes. It is also attempted to formulate methodology of assessing the values/benefits of the afforestation programmes based on field studies and literature available.

Objectives

1. To find out the various values added as a result of afforestation.

2. To assess the values in order to evaluate the level of success in the afforestation programmes.

Study Area

The study areas include representation of protected area (Sanctuary/National Park), major watershed, degraded forest and community land in Tamil Nadu.

Values of Afforestation Works

The following are the values identified for all afforestation works taken up in any land. Not all these values are expected in all afforestation sites/areas. Further, the priorities of these values may also differ according to the area and the objectives of the programmes.

* District Forest Officer, Dharmapuri (Tamil Nadu).

Values Identified :

A. Tangible Values :

1. Soil Conservation
2. Water Conservation
3. Biodiversity Value
4. Wildlife Value
5. Rural Employment
6. Productivity
7. Environmental Value
8. Socio-Economic Value
9. Economic Products

B. Intangible Values :

10. Aesthetic and Scientific Values

Description of Values

A. ***Material Values*** :

1. *Soil Conservation Value* : This is one of the values in watersheds. In recent years many of our afforestation activities are taken up on watershed basis. Further, in these areas considerable amount is allotted for soil conservation component under afforestation works. Therefore, it is very important to evaluate the afforestation programmes in such areas in terms of soil conservation value. The soil conservation works are done in various forms such as check dams, gully plugging, contour trenching, contour walls, etc., How for such soil conservation works are effective may be evaluated by determining the soil erosion rate. Certain formulae are already available for estimating the soil loss. The effectiveness of all the soil conservation works could be determined by estimating how much soil loss is prevented from erosion after the soil conservation works. For that, we may also require estimation from an untreated area as a control. The following formula/equation is suggested (Sivanappan, 1992) :

1. The equation is presented in the form :

$$A = RKLSCP$$

where,

A = Soil loss tonnes per/ha
R = Rainfall erosion index - a number which indicates the erodibility of the rain
K = Soil erodibility factor
L = Length factor
S = Slope factor
C = Crop management factor
P = Conservation practice factor

The lesser the "A" Value (compared to that of the untreated control area) the more the effectiveness. The effectiveness of the soil conservation works may be considered as good if soil loss is reduced nearer to 30% as a result of soil conservation works.

2. *Water Conservation Value* : This is another important factor in afforestation works taken up in slopes and in watershed areas. All the soil conservation works plus vegetative cover works are responsible for conservation of water by checking run-off and by improving percolation. The rain water falling on the land should not be allowed to go waste into the sea. Instead, it should be allowed to percolate into the soil as much as possible so as to improve the water table and prolonged stream flow. This can be done by checking run-off rate by various methods of water harvesting. The effectiveness of water conservation works could be assessed by determining the run-off rates. The method of estimation run-off rate is given by Sivanappan (1992) as follows :

A Rational Method used upto catchment size of 250 ha :

$$Q = \frac{CIA}{360}$$

Where,

Q = Cubic metres per second (Cumec)
C = Run-off coefficient (Constant)
I = Intensity in minimum for a duration
A = Area of catchment in hectares.

The "C" values for different land use, soil and slopes are given by Sivanappan (1992). In the above formula lesser the "Q" Value, more is the water conservation through percolation.

3. *Biodiversity Value* : Biodiversity value is one of the recent concepts mainly aimed in the protected areas (Sanctuaries and National Park). Recent years all the afforestation works are taken up with the main objective of improving the biodiversity of the said area. There are many factors responsible for determining the biodiversity values. Vegetation structure, soil moisture and soil nutrient etc. are said to be some of the factors responsible for biodiversity (Krebs, 1972). Thus, any afforestation works have direct impact on biodiversity. There are some methods to determine the biodiversity value.

A simple formula called Shipson's index "D" is one of the methods to determine Biodiversity Index of a given site:

$$D = \frac{N\,(N-1)}{\Sigma n\,(n-1)}$$

where,

N = Total individuals of all species.
n = No. of individuals of a species.

By this index "D", one can compare the biodiversity value of an area before and after afforestation. Even 10% increase in the "D" value after afforestation work may be considered as a good impact of afforestation.

4. *Wildlife Value* : Afforestation works have definite impact on wildlife. The impact on wildlife may also be determined by diversity index discussed already. Here, value specific for wildlife may be discussed under wildlife conservation value. Till recently no quantification of conservation value was described. However, Daniels *et al.* (1991) have attempted assigning conservation values for wildlife. They have developed several formulae for different conservation values. They may be adopted suitably for determining wildlife value added as a result of afforestation. However, here, a simple formula for assigning wildlife value is developed as follows :

$$DV = (D-d) / (D-1)$$

Where,

DV is the diversity value,
D is the density of a species on an afforested area, and

d is the density of the some species in a control area or in the same area before afforestation.

The above formula is most opt for evaluating afforestation works with the object of improving the habitat for one or more species.

5. *Rural Employment* : Forestry is one of the major employment generation scheme. It is assessed that 70 to 80% of total expenditure on afforestation works goes for payment of wages. Thus, thousands of people are benefitted through employment in forestry

activities and afforestation programme may be considered as one of the poverty alleviation programmes especially among poor villagers and tribals. In some of the afforestation programmes which are take up under tribal development scheme, Interface Forestry Scheme, Drought Prone Area Programme (DPAP), Employment Assurance Scheme (EAS) etc., employment generation is one of the main objectives. In such cases, the success of the scheme is mainly assessed based on number of man days generated and utilized. The rural employment value may be assessed based on the percentage of money spent on employment generation out of the total amount sanctioned for afforestation.

6. *Productivity* : Here, the productivity value refers to plantation raised for the production of timber, fuelwood, pulpwood etc. Under this afforestation programmes, the tree raised will ultimately be cut and utilized based on the rotation age fixed. The value here is mainly commercial. Such commercial plantation value is assessed based on benefit cost ratio. The benefit cost ratios have been already worked out for many forestry species like *Eucalyptus, Casuarina, Acacia* etc.

7. *Environmental Value* : Environmental value of afforestation programmes mainly refers to providing pollution free environment. The main objective of urban forestry is to create an ideal environment. Trees provide shade and thereby cool the environment. They absorb excess CO_2 emitted by industries and vehicles. Increase in the atmosphere CO_2 increase the atmosphere temperature. Further, trees reduces sound pollution by absorbing the sound. Thus, the environmental value in any urban forestry may be determined by the area of trees crown cover; the latter is directly proportional to CO_2 absorption and O_2 production.

8. *Socio-Economic Value* : In some afforestation programmes taken up under Interface Forestry, and in tribal villages, socio-economic value is considered as a high value. Here, uplifting the socio-economic conditions of the local people is the main objective. The quantification of the socio-economic value may be determined by the number of families benefitted and number of families lifted above poverty line as a result of afforestation activities. This may be achieved through employment generation or from the benefit derived from usufructs and MFP collections.

9. *Economic Products* : This mainly refers to various products obtained from the tree crop such as fruit, fodder, manure, small fuelwood and other MFP. Unlike productivity value, here the trees are not felled, but maintained for sustained yield. The value of the economic products obtained from the tree crop may be assessed from the benefits cost ratio or IRR. The benefit cost ratio and IRR for some species like *Azadirachta indica, Leucaena leucocephala* etc., are already worked out (Anon., 1995). The same criteria may be followed to find out the economic products value.

B. ***Non-Material Values*** :

10. *Aesthetic and Scientific Values* : These are the values often ignored but forms a main source of income through tourism. Road side parks avenue created by tree planting are of more aesthetic value. Certain species of trees provide good scope for scientific studies. Although these values are difficult to be quantified, it definitely add the value to the afforestation programme and therefore they should not

be ignore while assessing the values of our afforestation programmes.

Assessment and Quantification of Values

From the above description one may be able to quantify the different values and thereby assess the level of success of the afforestation programmes. To simplify the methodology each value is given three different scores that is 33%, 66% and 100% for different level of success.

The criteria to be followed for assigning the above percentage scores are described in Table 1.

Priority Assignments for Different Afforestation Programmes : Afforestation programmes are carried out in different forest areas with different objectives. Thus, the priorities of the values described earlier may differ according to the objectives of the afforestation programmes of the site. The major afforestation programmes with different objectives may be broadly grouped under the following categories.

(a) Afforestation in protected areas
(b) Afforestation in watershed areas
  1. Ecozone afforestation
  2. Interface afforestation
(c) Commercial plantation
(d) MFP plantation
(e) Community plantation
(f) Afforestation under Employment Assurance Scheme.

Assignment of Relative Values to the Prioritized Items : In order to have a quantified assessment for the values according to their priorities, different scores for each value are assigned. The total score of all the values taken as 100 and this 100 is distributed to all the 10 items according to the priorities under different afforestation programmes, which are furnished in Table 2.

Method of Assessment and Evaluation of the different Afforestation Programmes

Tables 1 and 2 provide the assessment and the relative importance of each value in percentage. If maximum is achieved for all values, the said programmes would get the score of 100% (Table 2). But, it is not normally possible to get full score for each value. For giving score for each value the criteria given in Table 1 should be followed. Although it is not based on any scientific studies, it would help to quantify the value to an acceptable norms. Any quantified assessment with some defined criteria and principles is definitely more valuable than an assessment without any acceptable quantified values.

Value Index

In order to compare the achievement with reference to total expenditure made on a said afforestation programme, it is proposed to develop an value index. For example a 90% score in an afforestation programme with an expenditure of Rs. 5000/ha is more valuable than a 90% score with an expenditure Rs. 10,000/ha. Therefore, it is essential to develop an value index in order to compare the relative success of different afforestation programmes. The value index proposed is as follows :

$$\text{Value Index (VI)} = \frac{\text{Percentage Score}}{\text{Expenditure in Rs. Thousands per hectare}}$$

Table 1

Criteria for giving different scores for each value

Sl. No.	Values Identified	Criteria for giving different scores		
		30%	66%	100%
01	Soil Conservation Value	Soil loss in reduced 5 to 10%	Soil loss in reduce 11 to 30%	Soil loss is reduced above 31%
02	Water Conservation	Run-off the rate reduced 10 to 20%	Run-off rate reduced 21 to 30%	Run-off rate reduced above 31%
03	Biodiversity Value	Biodiversity index increased by 5 to 10%	Biodiversity index increased from 11 to 25%	Biodiversity index increased above 25%
04	Wildlife Value	increase of 'DV' value by 5% - 10%	increase in 'DV' value by 11% - 20%	increase in 'DV' value above 20%
05	Employment Generation	40% to 50% the total expenditure goes for generation of employment	51% to 71% goes for employment generation	above 70% goes for employment generation
06	Productivity Value	Cost benefit ratio 1:2	Cost benefit ratio 1:3	Cost benefit ratio 1:4 & above
07	Environmental Value	Closure of over head canopy cover after 10 Years 20 - 20%	Closure over heads canopy cover after 10 Years 31 - 50%	Closure of canopy cover above 51%
08	Socio-Economic Value	No. of families benefitted increased between 20 and 30% out of total dependent families of the Village.	No. of families benefit-ted increased between 31-50%	No. of families benefitted increased above 50%
09	Economic-Products Value	I.R.R. 10 - 15%	I.R.R. 16 - 20%	I.R.R. above 20%
10	Aesthetic and Scientific	Aesthetic value felt by 20-25% of the people enquired	Aesthetic value felt by 26 - 50%	Aesthetic value felt by more than 50% of the people.

Table 2

Prioritisation of values for afforestation programmes in different lands / different afforestation areas and their relative importance

Types of values	Protected Area (Gap planting)		Eco-Zone		Production Zone		Interface Zone		Comunity Land (Social Forestry)		Commercial Plantation		Employment Assurance Scheme	
	PN	RI	PN	RI	PN	RI	PN	RI	PN	RI	PN	RI	PN	RI
1. Soil Conservation	7	4	2	20	2	20	1	20	6	5	5	8	4	5
2. Moisture Conservation	8	3	3	15	3	10	2	20	7	5	6	5	5	5
3. Bio-Diversity	1	40	1	30	6	05	7	05	10	2	-	-	-	-
4. Wildlife	2	20	6	5	7	05	8	05	8	3	8	3	-	-
5. Employment Generation	5	5	4	15	5	10	5	10	3	10	3	10	1	60
6. Productivity	9	2	-	-	4	10	3	15	1	50	1	40	-	-
7. Environmental	3	15	5	10	8	05	9	05	4	8	1	4	6	5
8. Socio-Economic Value	10	-	-	-	9	03	6	08	5	5	4	10	2	15
9. Aesthetic	4	6	7	05	10	02	10	02	9	2	-	-	-	-
10. Economic-Product	6	5	-	-	3	30	4	10	2	10	2	20	3	10

PI = Priority No. RI = Relative Importance (%)

The above value index should be compared between two afforestation programmes with similar objectives and priorities and it should not be compared with the afforestation programmes with different objectives and priorities.

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SUMMARY

In the Forest Department so far no qualified analytical method to evaluate afforestation works is available. This is the first attempt to evaluate the afforestation works by identifying all the values obtained. The relative importance of each value is discussed with reference to particular afforestation works. This will help to understand which value should be given priority in any afforestation works according to the object of management. The methodology will pave way to further thinking on this issue so as to bring out still refined methods.

वनीकरण कार्यों में मिलाए मूल्य योगों का मूल्यांकन

एस० पाल राज

सारांश

वन विभाग में इस समय वनीकरण कार्यों का मूल्यांकन करने की कोई प्राधिकृत विश्लेषण रीति प्रचलित नहीं है । यह प्रथम अवसर है जब उनसे मिले सभी मूल्यों की पहचान करके वनीकरण कार्यों के मूल्यांकन का प्रयास किया गया है । विशिष्ट वनीकरण कार्यों के संदर्भ में प्राप्त हुए प्रत्येक मूल्य के आपेक्षिक मूल्य का विवेचन किया गया है । किसी वनीकरण कार्य विशेष में प्रबन्ध करने के उद्देश्य को दृष्टि में रखते हुए कौन से मूल्य को उसमें पूर्वता दी जाए इससे यह समझने में सहायता मिलेगी । इस रीति-विज्ञान से इस विषय में आगे के चिंतन का मार्ग भी खुलेगा जिससे इससे भी अधिक परिष्कृत रीतियों का विकास किया जा सकेगा ।

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GENETIC IMPROVEMENT OF TEAK

VINOD KUMAR*, H.R. KOTRANGE** AND U.P. DHOTEKAR**

Maharashtra Van Sanshodhan Sanstha, Chandrapur (Maharashtra)

Introduction

Genetically superior seed is necessary for raising Teak plantations. The object of genetic improvement of Teak is to produce better quality, superior origin seed which would give better growth rate and higher productivity. The need for this was recognised by Maharashtra Forest Department as early as 1968 and Maharashtra Van Sanshodhan Sanstha was created at Chandrapur (Maharashtra) in 1968 having a Genetic Section in it. Maharashtra Forest Department has been pioneer in starting systematic programme on Genetic Improvement of Teak. Genetic Improvement Programme in Maharashtra State has been systematically planned. The achievements are being described as under.

Selection of Teak Seed Production Areas

Phenotypically better Teak stands have been selected as seed production areas. These areas are located in different agroclimatic zones for optimum genetic variability. Details of these areas are given in Table 1.

Selection of Plus Trees

The essence of plant breeding is to isolate superior strains that are occasionally observed in nature. The first step towards formation of a genetically superior seed orchard is therefore selection of superior quality trees, known as plus tree, in natural stand or plantations.

Plus trees are found scattered and far off from each other in the forest. It is not possible to obtain cross pollination between them in natural circumstances. Therefore vegetatively grown replicas known as clones are first prepared and then planted in the orchard, near each other to get cross pollination between the desired parents, i.e. plus trees through their clones.

Selection of plus trees is a long drawn out and meticulous process for which expensive and intensive work is necessary. Following criterion has been followed while selecting the plus trees :

(1) Tree should be predominant and conspicuously tallest and biggest in diameter growth, over the trees of same age group, growing in the vicinity. Timber volume of plus tree should be 25% more than the average volume of the check trees or comparison trees which are 4 to 5 in number.

(2) The height of the tree should be close

* Director & Silviculturist. ** Range Forest Officers.

Table 1

Teak Seed Production Areas

Teak Seed Production Area No.	Forest Division	Range	Comptt. No.	Area (ha)
MR/WC/1	Central Chandrapur	Dhaba	395	20.00
MR/WC/2	-do-	-do-	390	5.00
MR/PD/3	Allapalli	Pedigundam	99A	48.00
MR/PD/4	-do-	-do-	36A	12.00
MR/PD/5	-do-	-do-	86	13.00
MR/AL/6	-do-	Allapalli	33	15.00
MR/AL/7	-do-	-do-	38A	74.00
MR/AL/8	-do-	-do-	35	30.00
MR/AL/9	-do-	-do-	35	20.00
MR/AL/10	-do-	-do-	36,65	6.00
MR/AL/11	-do-	-do-	36	5.00
MR/AL/12	-do-	-do-	36A	8.00
MR/AL/13	-do-	-do-	36A	8.00
MR/AL/14	-do-	-do-	65	5.00
MR/AL/15	-do-	-do-	60	42.00
MR/AL/16	-do-	-do-	98	11.50
MR/AL/17	Sironcha	Sironcha	211	40.00
Total area :				363.00

to the upper height limit of the quality class for the species growing on that site.

(3) The tree should possess strong apical dominance and should have a long unforked bole, which usually is a result of late flowering.

(4) The tree should be free from flutes or buttresses, only in case of a mature plus tree, minor fluting, if present, should not extend above 30 cm from ground level.

(5) The tree should be vigorously growing, the leaves should possess the healthy natural shade or colour, characteristic of that provenance or variety.

(6) Stag headed trees are avoided, branches of the tree should be thin, with self pruning ability. The knot-free clean bole is the outcome of this property.

(7) The bole of the tree should be free from all defects and diseases such as knots, twists, forks, crookedness, epicormic branches, insect galleries, fungus, rot etc.

(8) The bark of the tree should be as smooth as possible and it should have vertical fissures all over its length as vertical fissures ensure straight grain.

(9) The branches on the bole, as far as possible should make obtuse angle with the main stem and crown should be slender, compact and nearly one-third in length of the height of the tree.

(10) The tree should not be a wolf tree.

(11) The tree should produce abundant quantity of viable seeds.

So far 23 Teak Plus Trees have been selected under Maharashtra Van Sanshodhan Sanstha, Chandrapur (Table 2).

Teak Seed Orchard

Teak seed orchard is a plantation of genetically superior clones developed from plus trees through vegetative method. Randomized statistical design is used for planting of Teak clones to give equal chances to all clones for cross-pollination. Teak clones are first raised in the Lohara nursery by bud grafting on Teak stumps in January and February and then planted in Teak seed orchard area. First clonal Teak Seed Orchard (TSO) of 1 ha was established in the year 1969 on an experimental basis at a spacing of 8 m x 8 m at Lohara and so far 29 Teak seed orchards have been raised on a regular basis in Lohara Research Station and Tadgaon Research Station under Maharashtra Van Sanshodhan Sanstha, Chandrapur (Table 3).

Regular observations are being recorded on flowering and fruiting of different clones. It was expected that each graft of Teak seed orchard will produce 2 kg Teak fruit annually from 6th year of establishment. Bud production of Teak fruit has been very low. Local clones give better returns. Among higher yielding local clones, important ones are MHAL-A4, MHAL-A8, MHSC-A4, MHSC-J2, MHAL-P2, and MHAL-P6. In clones of other States APT-20, APMN-4, APT-17, APT-4, APJNB-1, of A.P., ORPB-18, ORAN-P7, ORPB-18, of Orissa and TNT-17, TNT-18 of Tamil Nadu are better yielding ones.

Table 2

Teak Plus Trees selected by M.V.S.S.

Plus trees No.	Division	Range	Comptt. No.
MHAL - A1	Allapalli	Allapalli	1-A
MHAL - A2	"	"	1-A
MHAL - A3	"	"	66
MHAL - A4	"	"	80
MHAL - A5	"	"	65-B
MHAL - A7	"	"	20
MHAL - A8	"	"	65-B.
MHAL - A9	"	"	69
MHAL - P1	"	Pedigundam	99
MHAL - P2	"	"	88
MHAL - P3	"	"	86
MHAL - P4	"	"	86
MHAL - P5	"	"	102
MHAL - P6	"	"	102
MHAL - P7	"	"	160
MHAL - P8	"	"	99
MHAL - P9	"	"	89
MHSC - J1	Sironcha	Jimalgatta	60
MHSC - J2	"	"	58
MHSC - A1	"	Asarali	215
MHSC - A2	"	Asarali	296-B
MHSC - A3	"	Asarali	296
MHSC - A4	"	Asarali	296

Bud Multiplication Garden

Bud Multiplication garden has been established in 1979 at Lohara Research

Table 3

List of Teak Seed Orchards

Location	Year of Establishment	Area (ha)	Spacing (m x m)	No. of Clones	No. of grafts planted
1	2	3	4	5	6
Lohara Res. Stn. Compt. No. 407	1969	1.00	8 x 8	56	276
-do-	1979	5.00	8 x 8	30	780
-do-	1980	6.00	8 x 8	22	946
-do-	1981	8.00	8 x 8	23	1162
-do-	1982	5.500	8 x 8	40	847
Tadgaon Res. Stn. C. No. 104 Kothi.	1982	2.000	8 x 8	18	304
Lohara Res. Stn. C. No. 407	1983	12.5000	8 x 8	40	1962
Tadgaon Res. Stn. Kothi, C. No. 104	1983	5.000	8 x 8	40	780
Lohara Res. Stn. C. No. 409	1984	15.000	8 x 8	30	2190
Tadgaon Res. Stn. Kothi, C. No. 104	1984	10.000	8 x 8	64	1566
Tadgaon Res. Stn. Comptt. No. 194	1984	2.000	8 x 8	27	314
Lohara Res. Stn. Comptt. No. 409	1985	18.000	8 x 8	48	2802
Tadgaon Res. Stn. Kothi, C.N. 104	1985	10.000	8 x 8	27	1444
Tadgaon Res. Stn. C. No. 194	1985	2.000	8 x 8	18	314
Lohara Res. Stn. C. No. 397	1986	14.500	8 x 8	65	2279
Tadgaon Res. Stn. Kothi, C. No. 104	1986	10.000	8 x 8	40	1565
Tadgaon Res. Stn. Compt. No. 194	1986	2.000	8 x 8	26	312
Lohara Res. Stn. Compt. No. 397	1987	20.000	8 x 8	82	3051
Tadgaon Res. Stn. Compt. No. 104	1987	2.000	8 x 8	20	312

(Contd...)

1	2	3	4	5	6
Tadgaon Res. Stn. Compt. No. 194	1987	2.000	8 x 8	19	300
Tadgaon Res. Stn C. No. 180	1987	2.000	8 x 8	57	1550
Lohara Res. Stn. C. No. 397	1989	2.000	8 x 8	30	312
Lohara Res. Stn. Compt. No. 397	1990	2.000	8 x 8	31	312
Lohara Res. Stn. Compt. No. 397	1991	2.000	8 x 8	31	312
Lohara Res. Stn. Compt. No. 398	1992	2.000	8 x 8	31	312
Lohara Res. Stn. Comptt. No. 407	1993	2.000	8 x 8	29	312
Lohara Res. Stn. Compt. No. 398	1994	2.000	8 x 8	26	312
Lohara Res. Stn. Compt. No. 398	1995	2.000	8 x 8	26	312
Total Teak Seed Orchards		168.500			27240

Station. The main object is regular supply of buds or scion material required for grafting for the preparation of clones. Total 260 clones have been introduced in Bud Multiplication Garden as shown in Table 4.

National Germ Plasm Bank

Theoretically buds or scion from the plus trees alone should be used for raising Teak seed orchards. Finding out good genotype by progeny testing in case of Teak tree species is a long process. Therefore germ plasm of the plus trees are considered fit to be used for raising seed orchards, without waiting for the result of the progeny testing. The main object of National Germ Plasm Bank (NGPB) is to conserve a broad spectrum of genetic variability to serve as a reservoir for different needs. To achieve this object National Germ Plasm Bank has been established in Lohara Research Station in the year 1979 over an area of 6 ha. Till today 260 clones of different States having 3 rammets each have been planted at a spacing of 8 m x 8 m. Seeds obtained as a result of cross pollination between the clones of plus trees are treated, for all practical purposes, as one from the assumed source (Table 5).

Teak Seedling Seed Orchard

Seedling seed orchard is developed by raising seedlings obtained by seed sowing of selected plus trees. It is a tool for developing improved varieties by regular selection of better individuals in first, second and third generation seedling seed orchards. A first generation seedling seed orchard was developed in 1980 at Lohara Research Station over an area of 0.8 ha having

Table 4
Bud Multiplication Garden created by M.V.S.S..
No. of Clones planted year-wise.

States	Year																	Total
	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	
All India	-	-	-	-	-	-	-	-	3	-	3	4	1	1	2	2	2	18
Andhra Pradesh	31	-	-	4	3	-	2	-	-	-	-	-	-	-	-	-	-	40
Kerala	2	6	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	10
Madhya Pradesh	4	2	-	-	-	-	3	-	-	-	2	-	-	-	-	-	-	11
Orissa	3	-	-	9	5	-	9	1	5	5	4	-	-	5	1	1	18	66
Tamil Nadu	10	2	-	4	1	-	2	-	-	-	-	-	-	-	-	-	-	19
Karnataka	-	-	-	8	8	8	-	9	1	-	10	-	1	-	-	-	-	45
Arunachal Pradesh	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3
Gujarat	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	3
W. Bengal	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2
U.P.	-	-	-	9	3	-	-	1	-	-	-	-	-	-	-	-	-	14
Maharashtra	12	2	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29
Total	62	12	15	34	21	11	18	11	9	5	20	4	5	7	3	3	20	260

progenies of 9 plus trees of Allapalli and Sironcha Divisions. Till now 3.50 ha Teak seedling seed orchard has been raised. The main object is to study the character retention of plus trees in the next generation (Table 6).

Provenance Trials of Teak

The important part of the Genetic improvement of Teak is laying provenance trials. National level provenance trial was laid down in year 1980 involving 30 provenances of Teak of 8 States with the following objectives :

(1) To determine the extent of the pattern of variation between the provenance of a series with natural variation.

(2) To find out the most productive seed source in respect of quantity and quality and to provide material for further local breeding.

Out of 30 provenances of Teak only 25 have responded to the soil and climate of Chandrapur. The introduced provenance in some cases may prove better than the native strain but it is better to avoid use of seeds of provenance in raising new plantations. It will therefore be safe to use the best germplasm of the local strain in the Teak seed orchards for producing genetically improved seed for raising Teak plantation (Table 7).

Table 5

No. of Clones introduced in the Germ Plasm Bank

States	Year '79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	Total
Andhra Pradesh	37	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	40
Kerala	3	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	10
Tamil Nadu	16	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
Madhya Pradesh	-	3	-	-	3	-	-	-	-	-	1	-	-	-	-	-	-	7
Maharashtra	19	7	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	29
Karnataka	-	-	-	8	6	9	-	12	6	2	2	-	-	-	-	-	-	45
U.P.	-	-	-	9	4	-	-	1	-	-	-	-	-	-	-	-	-	14
All India	-	-	-	-	-	-	-	1	12	1	-	-	-	-	-	-	-	14
Orissa	25	-	-	-	-	-	-	-	12	9	-	-	2	3	-	-	22	73
Arunachal Pradesh	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	3
W.Bengal	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-		2
Gujarat	-	-	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-	4
Total	100	20	-	18	20	9	-	14	35	12	4	-	3	3	-	-	22	260

Table 6

List of Seedling Seed Orchards raised by MVSS

Year	Location	Comptt. No.	Area (ha)	No. of Teak Clones	No. of Plants Planted	No. of Plants Survived	Survival Percentage
1980	Lohara	398	1.5	9	900	439	48.78
1992	"	398	1.0	5	625	613	98.08
1994	"	398	0.5	6	319	273	85.58
1995	Indersen Bardi	406	0.5	6	320	295	92.19
Total			3.5	26	2164	1620	74.86

Table 7

Details of Provenance Trial of Teak Area-wise

Provenances	R1		R2		R3		R4		Grand Total	
	Pl.	Sur.	Pl.	Sur.	Pl.	Sur.	Pl.	Sur.	Pl.	Sur.
Umaria	36	20	36	13	36	3	36	3	144	39
Nilambur	36	13	36	11	36	2	36	3	144	29
Bilaspur	36	15	36	2	36	-	36	8	144	25
Baitul	36	-	36	13	36	2	36	1	144	16
Topship	36	-	36	-	36	-	36	-	144	-
Kalipoury	36	1	36	-	36	-	36	-	144	1
Nammara	36	11	36	12	36	10	36	4	144	47
Durga	36	27	36	16	36	1	36	2	144	46
Bastar	36	17	36	20	36	-	36	4	144	41
Raipur	36	10	36	9	36	6	36	2	144	27
Hansur	36	6	36	-	36	-	36	-	144	6
Sumer	36	9	36	3	36	-	36	-	144	12
Sagar	36	18	36	-	36	-	36	-	144	18
Hoshangabad	36	19	36	21	36	-	36	5	144	45
Narsipattem	36	1	36	3	36	2	36	4	144	10
Amravati	36	4	36	2	36	-	36	4	144	10
Angul	36	6	36	12	36	-	36	2	144	20
Kangekumar	36	5	36	4	36	2	36	5	144	16
South Chanda	36	8	36	11	36	2	36	13	144	34
Khandwa	36	23	36	7	36	-	36	1	144	31
Malamathur	36	11	36	2	36	1	36	8	144	22
Kabji	36	20	36	3	36	2	36	6	144	31
Belapur	36	12	36	16	36	3	36	8	144	39
Panna	36	2	36	17	36	2	36	-	144	21
Wynad	36	15	36	-	36	1	36	3	144	19
Givha	36	24	36	16	36	-	36	3	144	43
East Melghat	36	24	36	14	36	5	36	12	144	37
Damoti	36	19	36	4	36	3	36	11	144	37
Central Chanda	36	5	36	26	36	5	36	-	144	36
Kharithar	36	3	36	8	36	-	36	-	144	11
Total :	1080	358	1080	265	1080	52	1080	112		787

SUMMARY

Genetic improvement of Teak has been undertaken under Maharashtra Van Sanshodhan Sanstha, Chandrapur in a systematic manner conducting identification of seed production areas, selection of plus trees, establishment of clonal Teak Seed Orchards and Teak Seedling Seed Orchards, establishment of Teak Germ Plasm Bank, as well as Bud Multiplication Gardens, Progeny testing and provenance trial. Thus efforts are being taken to produce genetically superior Teak trees by making use of principles of plant breeding. The works going on in MVSS, Chandrapur will go a long way in the field of Genetic Improvement of Teak.

सागौन में अनुवंशिकीय सुधार

विनोद कुमार, एच०आर० कोटरंगे व यू०पी० धोतेकर

सारांश

जैसा बताया गया है, महाराष्ट्र वन संशोधन संस्था, चन्द्रपुर के अधीन बीज उत्पादक क्षेत्रों की पहचान, श्रेष्ठतर वृक्षों का चुनाव, कृन्तकीय-सागौन बीज उद्यानों और सागौन पौधों के बीज उद्यानों की स्थापना, सागौन के जीवाणु प्ररस कोष और कलिका बहुलन उद्यानों की स्थापना, संतति संपरीक्षण तथा स्थानजों के परीक्षणों पर विधिवत् कार्य करके सागौन के आनुवंशिकीय सुधार का कार्य किया जा रहा है। इस तरह पादप प्रजनन सिद्धान्तों को उपयोग में लाकर आनुवंशिक दृष्टि से श्रेष्ठ सागौन वृक्ष उत्पन्न करने के प्रयास किए जा रहे हैं। महाराष्ट्र वन संशोधन संस्था में किए जा रहे इन कार्यों का सागौन के आनुवंशिकीय सुधार करने के क्षेत्र में दूरगामी प्रभाव पड़ेगा।

VARIATION IN ROOTING RESPONSE IN TEN PROVENANCES OF *AZADIRACHTA INDICA* A. JUSS

MOHIT GERA*, NEELU GERA*, S.L. MEENA AND TRIBHUVEN SINGH

Silviculture Division,
Tropical Forest Research Institute,
Jabalpur (Madhya Pradesh)

Introduction

Azadirachta indica (Neem) is a fast growing sturdy tree native to Indian subcontinent but cultivated throughout South-East Asia, Australia, Africa, many countries in Central and South America, the Caribbean islands, Puerto Rico, and the Virgin islands (Anon., 1993). The species has proved as one of the most suitable and valuable tree species for arid and semi-arid regions of India. It is an outstanding example of the species which is highly efficient in restoring soil productivity and at the same time providing fodder, fuelwood and raw material for products like medicines, pesticides, mosquito repellents, fertilizers, soaps, lubricants, gums, toothpastes, agricultural implements and even contraceptives. Considering its importance, the species has been included as a potential tree species for planting under various Agro- and Social Forestry programmes in different parts of the country.

The wide distribution of Neem and its growth under a variety of ecological zones is indicative of the presence of large genetic variability, the selective use of which can be made for yield improvement of the species. Provenance related variation in seed weight, leaf length, height growth, survivability, flowering and seed production have been reported in several studies (Rajawat *et al.*, 1994; Gupta *et al.*, 1995). Jacobson (1981) reported that Neem seed of Indian origin contained only 1-3% Azadiractin, whereas seed of African origin has an average of 5-6% with a few lots exceeding 9%, indicating large genetic variation. The selection procedure towards tree improvement in Neem would begin with provenance evaluation followed by clonal selection and multiplication of selected genotypes. The traditional methods of breeding, including hybridization have been of very limited use for the yield improvement of forest trees owing to their long generation times and the prevalence of outbreeding. This problem can be overcome to a large extent by using clonal techniques coupled with selective use of the considerable amount of genetic variations available within the wild population (Pal, 1992).

Amongst various methods of clonal propagation, the most economic method is that of rooting of branch cuttings. However, there are a large number of endogenous factors affecting the production of rooted vegetative propagules. These include nature of species, genetic variation within the species, maturation state of propagule donor, position of propagule on the donor, the type and size of propagule and time of collection. In this paper, the rooting response

* Presently Dy. Conservator of Forests, Jammu (J&K)

of different provenances of Neem under the effect of different treatments viz. IAA, IBA and Thiamine under intermittent mist conditions has been reported and discussed. The study was conducted in Tropical Forest Research Institute, Jabalpur.

Materials and Methods

Juvenile shoot cuttings were collected from ten indigenous provenances (Table 1) of *Azadirachta indica* in second week of March, 1997. The cuttings were 22 cm long and around 1.5 cm thick. The cuttings were surface sterilized with 0.1% Bavistin for 4-5 minutes and washed thoroughly with water. The top cut end of the cuttings was sealed with paraffin wax. The cuttings were given following treatments at the basal end for 30 seconds (Quick dip method).

T_1 - Thiamine 1000 ppm

T_2 - Indole Acetic Acid (IAA) 1000 ppm

T_3 - Indole Butyric Acid (IBA) 1000 ppm

T_4 - Control

Thirty cuttings belonging to each provenance were planted under each treatment and all the treatments were replicated thrice. A total of 1200 cuttings were planted i.e. 10 provenances x 4 treatments x 3 replications with ten cuttings per replication in factorial randomized block design. The treated and control cuttings were set in the rooting medium of sterilized course sand at a spacing of 10 cm x 10 cm under intermittent mist conditions at 30 ± 2°C and RH 70-80%.

The observations on number of rooted cuttings, number of roots, root length and root dry weight were recorded after 70 days of planting. The data on rooting percentages was subjected to arc-sine transformation for statistical analysis.

Results and Discussion

The effects of various treatments, provenance differences and their interactions (Table 2) were found to be significant for almost all parameters studied. Of the various treatments tried, treatment T_3 i.e., IBA 1000 ppm proved to

Table 1

Geographical location of different provenances of Azadirachta indica

S.No.	Provenances	Latitude	Longitude	Altitude (m)
P_1	Sagar, (Madhya Pradesh)	21°51'N	78°45'E	527
P_2	Ramannaguda, Rayagada (Orissa)	19°05'N	83°49'E	250
P_3	Kalyani, Nadia (West Bengal)	23°01'N	88°27'E	45
P_4	Jabalpur (Madhya Pradesh)	23°55'N	79°59'E	400
P_5	Kulapachra, Midnapur (West Bengal)	22°28'N	87°18'N	75
P_6	Ballarshah (Maharashtra)	19°51'N	79°25'E	250
P_7	Allahabad (Uttar Pradesh)	25°28'N	81°54'E	320
P_8	Annur, Coimbatore (Tamil Nadu)	11°17'N	77°07'E	360
P_9	Mandore, Jodhpur (Rajasthan)	26°18'N	73°01'E	224
P_{10}	Ghatti Subramanya, Dodaballapur (Karnataka)	13°22'N	77°34'E	950

Table 2

Rooting behaviour of provenances under different treatments

Prov./ Treat-ment	T_1	T_2	T_3	T_4	Mean
1	2	3	4	5	6
			Rooting percentage		
P_1	56.67 (48.85)	60.00 (50.77)	86.67 (68.61)	33.33 (35.24)	59.17
P_2	53.33 (46.89)	46.67 (43.11)	83.33 (65.88)	43.33 (41.15)	58.33
P_3	60.00 (50.77)	56.67 (48.85)	76.67 (61.14)	46.67 (43.11)	60.00
P_4	43.33 (41.15)	63.33 (52.71)	76.67 (61.14)	30.00 (33.21)	53.33
P_5	50.00 (45.00)	36.67 (37.29)	73.33 (58.89)	40.00 (39.23)	50.00
P_6	60.00 (50.77)	76.67 (61.14)	80.00 (63.44)	50.00 (45.00)	69.17
P_7	50.00 (45.00)	76.67 (61.14)	73.33 (58.89)	43.33 (41.15)	60.83
P_8	50.00 (45.00)	60.00 (50.77)	80.00 (63.44)	43.33 (41.15)	58.33
P_9	60.00 (50.77)	66.67 (54.76)	73.33 (58.89)	56.67 (48.85)	64.17
P_{10}	46.67 (43.11)	80.00 (63.44)	96.67 (79.53)	50.00 (45.00)	68.33
Mean	53.00	63.00	81.00	43.67	
C.D.(5%)	P=6.26***	T=3.96***	P * T =12.52*		
			Number of roots per cutting		
P_1	6.00	7.00	16.89	4.44	8.58
P_2	8.55	8.89	15.89	4.78	9.53
P_3	5.11	9.45	16.22	3.69	8.72
P_4	6.61	11.00	14.89	4.11	9.05
P_5	6.22	6.22	17.67	4.56	8.67
P_6	4.22	7.00	15.55	4.22	7.75
P_7	5.44	7.55	12.87	4.11	7.50
P_8	5.10	7.42	15.53	5.20	8.32
P_9	12.00	7.00	14.33	5.22	9.64
P_{10}	9.67	7.55	16.22	5.44	9.72
Mean	6.89	7.91	15.61	4.58	
C.D.(5%)	P=0.86***	T=0.55***	P * T = 1.51***		
			Maximum Root Length		
P_1	4.26	5.15	6.42	3.57	4.85
P_2	4.04	4.95	6.60	4.19	4.95

Contd...

1	2	3	4	5	6
P_3	3.45	4.52	4.74	3.17	3.97
P_4	4.81	5.59	6.67	3.76	5.21
P_5	5.48	4.64	7.61	3.55	5.32
P_6	4.39	6.19	6.76	5.28	5.65
P_7	3.31	4.98	6.70	3.68	4.67
P_8	4.03	6.10	8.20	4.64	5.74
P_9	6.09	5.83	7.94	4.73	6.15
P_{10}	4.79	6.09	6.77	4.16	5.45
Mean	4.46	5.40	6.84	4.07	
C.D. (5%)P=0.67***		T=0.42***	P * T = NS		
		Root Dry Weight			
P_1	0.036	0.053	0.071	0.025	0.046
P_2	0.032	0.058	0.071	0.028	0.047
P_3	0.033	0.078	0.064	0.033	0.052
P_4	0.056	0.068	0.122	0.043	0.072
P_5	0.087	0.029	0.163	0.020	0.075
P_6	0.016	0.053	0.071	0.043	0.046
P_7	0.020	0.065	0.125	0.041	0.063
P_8	0.030	0.054	0.072	0.033	0.047
P_9	0.071	0.060	0.134	0.034	0.075
P_{10}	0.032	0.066	0.134	0.025	0.064
Mean	0.041	0.058	0.102	0.032	
C.D. (5%)P=0.009***		T=0.006***	P * T = 0.018***		

Significance level : *P<0.05, **P<0.01, ***P<0.001

be the best for all the parameters studied. The treatment increased rooting by 85.5%, number of roots per cutting by 240.8%, maximum root length by 68% and root dry weight by 218.7% over control.

Out of the ten provenances, the provenance P_6 performed the best with 69.17% mean rooting, which is at par with provenances P_9 and P_{10}. The provenance P_5 showed minimum rooting (50%) which is at par with P_4. The provenance P_{10} gave maximum of roots per cutting i.e. 9.72 per cutting which is at par with provenances P_9, P_2 and P_4. The provenance P_7 gave minimum number of roots (7.50 per cutting) which was at par with provenances P_6 and P_8.

The provenance P_9 gave maximum root length i.e. 6.15 cm which was at par with provenances P_6 and P_8. The provenance P_3 gave minimum root length (3.97 cm). Maximum root dry weight was obtained in case of provenances P_5 and P_9 i.e. 0.075 gm/

cutting which was at par with provenance P_4. The provenances P_1 and P_6 gave minimum root dry weight per cutting (0.046 gm).

Regarding interaction effects, $P_5 * T_3$ performed the best in yielding maximum number of roots per cutting (17.67) and root dry wt. (0.163 gm/cutting). The same interaction along with $P_9 * T_3$ also performed at par with the best interaction i.e. $P_8 * T_3$ (8.20 cm) for maximum root length. The interaction $P_{10} * T_3$ gave maximum rooting percentage (96.67%) which was at par with $P_1 * T_3$ (86.67%).

The study has shown that the treatment IBA 1000 ppm gave best performance in all the four parameters studied. Palanisamy and Pramod Kumar (1996) have reported similar results with IBA 1000 ppm resulting in rooting upto 80%, in case of branch cuttings obtained from 20 years old trees. The present study has shown even higher percentage of rooting i.e., upto 96.67%, probably due to juvenile cuttings used in the experiment.

Significant variations were observed in all the parameters studied among the provenances in rooting response to various treatments. This shows that the genotype of the donor plant has a strong effect on the rooting ability of the cuttings. Genetic factors are known to affect the rooting behaviour of cuttings of many woody plant species (Hartmann and Kester, 1983; Pal, 1989). Similar clonal variations were also reported by Pal *et al.* (1994) in rooting percentage, number of roots per cladode and mean root length in rooting trial of ten different clones of *Casuarina equisetifolia*.

This findings of the present study indicate that it is desirable to include rooting ability of a provenance as an important criterion for its selection and evaluation. This becomes more important where large scale clonal propagation is required for immediate yield improvement in the species.

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SUMMARY

The rooting response of ten indigenous provenances of *Azadirachta indica* under the effect of different treatments viz., IAA, IBA and Thiamine was studied in a factorial RBD experiment. Signifiant variations in almost all parameters were recorded among the different provenances, treatments and their interactions. The treatment IBA 1000 ppm performed the best for all the parameters studied. The treatment increased rooting by 85.5%, number of roots per cuttings by 240.8%, maximum root length by 68% and root dry wt. by 218.7% over control. The provenance Mandore, Rajasthan (P_9) showed overall best rooting response with 64.17% rooting, 9.64 number of roots per cutting, 6.15 cm maximum root length and 0.075% gm/cutting root dry wt. The interaction of provenance Midnapur, West Bengal (P_5) with treatment IBA 1000 ppm (T_3) gave best results in respect of number of roots per cutting (17.67), maximum root length (7.61 cm) and root dry weight (0.163 gm/cutting). However, the provenance Dodaballapur, Karnataka (P_{10}) with treatment IBA 1000 ppm (T_3) gave the maximum rooting (96.67%). The findings indicate that it is desirable to include rooting ability of a provenance as an important criterion for its selection and evaluation.

अजेडिरेक्टा इंण्डिका ए० जुस्शो के दस स्थानज भेदों में जड़ें निकलने के प्रतिचार की भिन्नता

मोहित गेरा, नीलू गेरा, एस०एल० मीणा व त्रिभुवन सिंह

सारांश

अजेडिरेक्टा इंण्डिका के दस देशज स्थानज भेदों में विभिन्न उपचारों अर्थात् इण्डोल एसेटिक अम्ल, इण्डोल ब्यूटरिक अम्ल और थायामीन के प्रभावों के अन्तर्गत जड़ें निकलने के प्रतिचार का अध्ययन एकादिहत आरबीडी संपरीक्षण में किया गया । विभिन्न स्थानजों, उपचारों और उनकी अन्योन्य प्रतिक्रियाओं में लगभग सभी परीमापों में सार्थक अन्तर पड़ते देखे गए । अधीत सभी परिमापों के लिए इण्डोल ब्यूटरिक अम्ल 1000 भाग प्रति दस लाख भाग पानी उपचार सर्वाधिक सक्रिय पाया गया । इस उपचार से जड़ें निकलने में 85.5% प्रति कलम जडों की संख्या में 240.8%, जड़ की अधिकतम लम्बाई में 68% और जडों के शुष्क भार में 218.7% अधिक वृद्धि नियामक की तुलना में होती दिखाई दी । राजस्थान के मण्डोर स्थानजभेद (पी 9) में समग्रतः सबसे अधिक प्रतिचार जड़ें निकलने में 64.17%, प्रति कलम जडों की संख्या 9.64, जड़ की अधिकतम लम्बाई 6.15 सेमी० और जडों का शुष्क भार 0.075 ग्राम/ जड़ पाया गया । अन्योन्य प्रतिक्रिया पश्चिम बंगाल के मिद्नापुर स्थानजभेद (पी 5) की इण्डोल ब्यूटरिक अम्ल 1000 भाग प्रति दस लाख भाग पानी में (टी 3) करने पर प्रति कलम जडों की संख्या (17.67) जड़ की अधिकतम लम्बाई (7.61 सेमी०), जडों का शुष्क भार (0.163 ग्राम / कलम) की दृष्टि से सबसे अच्छी रही । तथापि, इण्डोल ब्यूटरिक अम्ल 1000 भाग प्रति दस लाख भाग पानी से उपचार (टी 3) करने पर अधिकतम जड़ें (96-67%) डोडाबल्लापुर, कर्णाटक स्थानज (पी 10) से निकली । ये मालूमात इंगित करती हैं कि स्थानजों का चुनाव और मूल्यांकन करने में उनकी जड़ें निकलने की योग्यता को भी महत्वपूर्ण कसौटी की भांति सम्मिलित करना वांछनीय रहेगा ।

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VEGETATIVE PROPAGATION OF *PANAX* SPECIES (GINSENG) IN ARUNACHAL PRADESH

A.N. RAO, K. HARIDASAN AND N.S. BISHT

State Forest Research Institute,
Itanagar (Arunachal Pradesh)

Introduction

The genus *Panax* belongs to the family Araliaceae and is popularly known as Ginseng. The roots of these plants have been used in Oriental medicine since ancient time because of saponin and sapogenin contents which have the stimulatory and adaptogenic properties. A perusal of literature reveals that the genus *Panax* is represented by 3 species viz. *P. sikkimensis, P. pseudoginseng* and *P. bipinnatifida* in Arunachal Pradesh (Banerjee, 1968; Mehta and Haridasan, 1992). According to a report (Vishwanathan *et al.,* 1993) India imported 45,688 kg of Genseng from international market during March 1992 worth Rs. 6,77,248 lakhs.

A review of literature indicates that some work has already been done on its cultivation from seeds (Joshi *et al.*, 1991; Vishwanathan *et al.*,1993). However, seeing the difficulty in getting in the seeds and low germination percentage, experiments were conducted to explore the possibility of raising the seedlings from the rhizomes. The rhizomes of *Panax bipinnatifida* and *P. sikkimensis* were collected from Tale Valley area and experiments were conducted to study the effect of hormones viz. Serootex (03), Indole Acetic Acid (IAA), Indole Butyric Acid (IBA), and Naphthalene Acetic Acid (NAA) on the growth and multiplication of rhizomes.

Materials and Methods

The experimental beds (5m x 1m) were prepared with 12.5 cm thick small pebbles and sand mixture layer at the bottom and about 15 cm thick layer of rich manure top soil on the top. Rhizomes were planted (full rhizomes as well as after making suitable pieces) at a distance of about 10 cm from each other. A polythene sheet cover was provided for diffused day light and to prevent snowfall on the beds. The serootex was applied on the cut ends of the rhizomes. The other treatments were provided by preparing the solutions of different concentration and rhizomes were dipped overnight. Following treatments were given :

(i)	Serootex 03	-	Applied on the cut ends of rhizomes
(ii)	IAA treatment	-	3 ppm and 5 ppm, (overnight)
(iii)	IBA	-	5 ppm (overnight)
(iv)	NAA	-	5 ppm (overnight)

Results and Discussion

The results of various experiments are presented in Table 1. In the case of *Panax bipinnatifida*, planting of rhizomes in full without any treatment proved ideal with

Table 1

Effect of different hormone treatment on survival and multiplication on Ginseng

Species	Treatments	Survival (%)	Additional (%) plants after one year
P. bipinnatifida	Control	80	25
"	Serootex on 2 piece Rhizome	65	23
P. sikkimensis	Control	89	46
"	Serootex on 2 piece Rhizome	86	54
"	Serootex on 3 piece Rhizome	65	18
"	Serootex on 4 piece Rhizome	50	21
"	IAA (3 ppm)	100	60
"	IAA (5 ppm)	100	20
"	IBA (3 ppm)	60	0
"	IBA (5 ppm)	60	0
"	NAA (3 ppm)	100	40
"	NAA (5 ppm)	100	120

80% survival rate and 25% multiplication rate when compared to the serootex treatment in which the survival is 65% and multiplication percentage is 23 only.

Similarly in *Panax sikkimensis* the planting of rhizomes without any cut and any treatment is more ideal to achieve high survival (89%) and multiplication rate (46%) than treating the cut pieces with serootex. However, it is noted that rhizomes which are cut into 2 pieces and treated with serootex have shown slightly better multiplication rate (54%) than the control ones.

In *Panax sikkimensis*, the best result were obtained by treating the rhizomes with 5 ppm Naphthalene Acetic Acid for 12 hours before planting i.e. 100% survival and 120% multiplication, as compared to the treatment with other hormones. 100% survival and 60% multiplication rate, were obtained, respectively in the case of rhizomes treated with IAA (3 ppm) while treatment with IBA (3 ppm and 5 ppm) proved to be less effective with 60% survival rate and no multiplication was observed in this case.

The results are quite encouraging and indicate that large scale cultivation of Ginseng can provide a good opportunity of income generation particularly to the high altitude dwellers. However, lot of work is required to standardize the cultivation technique so that a fool proof economically viable package can be given to people for its large scale cultivation.

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SUMMARY

This paper deals with the cultivation technique of two species of Ginseng viz. *Panax sikkimensis* and *P. bipinnatifida*. Result of the experiments conducted on the growth and multiplication of rhizomes by treating them with different hormones such as Serootex 03, IAA, IBA and NAA have also been discussed.

अरुणाचल प्रदेश में पैनेक्स जातियों (गिनसेंग) का वर्धी प्रवर्धन

ए०एन० राव, के० हरिदासन व एन०एस० बिष्ट

सारांश

इस अभिपत्र में गिनसेंग की दो जातियों अर्थात् *पैनेक्स सिक्किमेंसिस* और *पै० बाइपिन्नैटिफिडा* की कृषि प्रविधि का वर्णन दिया गया है। विभिन्न हार्मोनों जैसे सेरोओटेक्स 03, इण्डोल ऐसेटिक अम्ल, इण्डोल ब्यूटरिक अम्ल और नाइट्रिक ऐसेटिक अम्ल से उपचारित करके उनकी वृद्धि और शिफास्तम्भों के बहुलन पर किए गए संपरीक्षणों से मिले परिणामों का विवेचन भी किया गया है।

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DEVELOPMENT OF BAMBOO MAT - WOOD VENEER COMPOSITES AS WOOD SUBSTITUTE

B.N. RAJEEV, M.V. NAIDU, T.S. RANGARAJU,
S.S. ZOOLAGUD AND B.S. ASWATHANARAYANA

Indian Plywood Industries Research & Training Institute,
Bangalore (Karnataka)

Introduction

The wood based panel industries in India, which traditionally depend on natural forests for their raw material requirements are in a state of crisis now. This is mainly due to dwindling supplies of prime quality wood previously favoured and also increased demand for panel products in recent times. The situation has compelled the wood based panel industry to orient itself towards larger raw material base from renewable resources, viz., ligno-cellulosic materials instead of wood substitution by plastics, metals and minerals due to limited source of supplies, high energy requirements and environmental pollution considerations. Technological innovations emerged in recent times particularly with respect to processing machineries and advent of synthetic resins have motivated the technologists for the optimal utilization of this versatile raw material for the production of panel products for various end uses. Various strategies have been evolved in different countries for the conservation of prime quality wood and its judicious use for the production of wood based panels in combination with lesser known secondary wood from plantation or fast growing species and agricultural residues to comply with functional requirements of the panels keeping in view techno-economical as well as acceptance of such panels by the users.

Development of Bamboo Mat - Wood Veneer Composites

Based on research and development work carried out at IPIRTI, it is now clearly established that it is possible to make thinner bamboo mat boards economically (Zoolagud and Rangaraju, 1991). Several entrepreneurs have already started using the technology developed at IPIRTI to manufacture exterior grade bamboo mat boards. Studies conducted at the Institute have also revealed the requirement of higher quantity of PF resin for the manufacture of bamboo mat boards beyond 6 mm thickness and this would increase the cost of the panel production and hence was not favoured for commercial production.

Extensive studies were conducted to find out the end use applications for bamboo mat board developed at the Institute. Studies have established the suitability of bamboo mat board for non-load bearing applications similar to plywood in areas like housing, packaging, storage and transportation (Damodaran and Jagadeesh, 1991). Utilization of bamboo mat board for load bearing structural applications similar to structural plywood, concrete shuttering plywood etc., were not found suitable due to lower strength and stiffness ratio to that of density of bamboo mat board (Damodaran and Jagadeesh, 1993).

Test methods were developed at the Institute to evaluate bond quality of bamboo mat board (Naidu and Aswathanarayana, 1991). Subsequently, Bureau of Indian Standards have brought out Indian Standard Specification on Bamboo Mat Board for general purposes (Anon., 1994). Physical-mechanical properties of bamboo mat boards were evaluated by adopting standard test procedures for plywood (Anon., 1983).

Extensive investigations have been carried out at the Institute to find out the suitability of lesser known timber species as well as plantation grown species to widen the raw material base for plywood industry in the country. Table 1 gives Physical-mechanical properties of lesser known species such as *Duabanga grandiflora, Tetrameles nudiflora, Artocarpus chaplasha, Parishia insignis, Alnus nepalensis, Paraserianthes falcataria, Hevea braziliensis* etc. As can be seen from the results, plywood manufactured from these species does not conform to the requirements of Indian Standard Specification for structural plywood (Anon., 1983).

It is in the above context that bamboo emerges as a suitable material of immense potential. It is the fastest growing plant species harvestable in 2 to 6 year cycles and

Table 1

Physical-mechanical properties of plywood by using lesser known species as well as plantation grown species for the manufacture of structural grade plywood

Property	*Duabanga grandiflora*	*Tetrameles nudiflora*	*Artocarpus chaplasha*	*Parishia insignis*	*Alnus nepalensis*	*Artocarpus chaplasha* (Andamans)	*Paraserianthes falcataria*	*Hevea braziliensis*
Density (kg/m³)	559	407	502	552	450	458	416	520
Tensile strength (kg/cm²)								
(i) Along	441	202	258	526	360	505	217	493
(ii) Across	310	197	302	334	290	325	206	380
Compressive Strength (kg/cm²)								
(i) Along	287	190	280	306	285	315	195	309
(ii) Across	303	176	275	295	265	306	165	228
Modulus of Rupture (kg/cm²)								
(i) Along	528	327	470	516	460	509	284	637
(ii) Across	451	224	326	305	315	310	219	387
Modulus of Elasticity (kg/cm²)								
(i) Along	65467	46550	63186	55234	58105	52456	41367	78675
(ii) Across	36229	27890	27836	26436	26275	25342	25476	36430
Modulus of rigidity (kg/cm²)	5468	4540	4678	5145	5675	5242	4326	5140

on par in its physical and mechanical properties to wood. In panel form it is more versatile in applications than reconstituted panels such as particle boards.

Hence studies were initiated at the Institute under IDRC sponsored project to find out the suitability of bamboo as an alternate to wood. One of the objectives of the project is to develop structural panels based on bamboo in combination with short rotation plantation grown species like *Grevillea robusta*, which is commonly used for plywood manufacture for general purposes.

In this paper methodology adopted for the manufacture of bamboo mat-wood veneer composites aiming to make the panel suitable for structural applications have been briefly described.

Materials and Methods

PF resin for bamboo mats : PF resin developed for the manufacture of bamboo mat board and method of resin application were similar to the ones developed at the Institute (Zoolagud and Rangaraju, 1990).

PF resin adhesive for wood veneers : PF resin adhesive used was similar to the one developed at the Institute (Naidu and Aswathanarayana, 1987).

Bamboo Mats : Mats made from *Melocanna bambusoides* species woven at 45° (Herringbone weave) with moisture content around 15% were used for the manufacture of composite panels. Thickness of slivers were varying from 45% of the nominal thickness of 0.6 mm. Mat sizes were 2.5 m x 1.25 m for the manufacture of 2.44 m x 1.22 m composites panels.

Wood Veneers : Rotary cut veneers from *Grevillea robusta* were used for the manufacture of composite panels. Moisture content of veneers was in the range 4 to 6%. Thickness of veneers was 2.4 mm and size being 2.5 m x 1.25 m for the manufacture of 2.44 m x 1.22 m composites in different thickness.

Manufacture of Bamboo Mat - Wood Veneer Composites

Construction of resin treated bamboo mats and/or wood veneers for the manufacture of composite panels tested so far are as follows :

Code No. 1 : 2.0 mm panel with 2 mats. (100 % replacement of wood).

Code No. 2 : 3.0 mm panel with 3 mats. (100% replacement of wood).

Code No. 3 : 6.0 mm panel with 5 mats. (100% replacement of wood).

Code No. 4 : 8.0 mm panel with 7 mats. (100% replacement of wood).

Code No. 5 : 4.0 mm panel with 1 veneer and 2 mats. Mats as faces. (50% replacement of wood).

Code No. 6 : 6.0 mm panel with 1 veneer and 4 mats. Two mats on either side of the veneer. (67% replacement of wood).

Code No. 7 : 19.0 mm panel with 2 veneers and 12 mats. Wood veneer as faces and mats as core. (75% replacement of wood).

Code No. 8 : 16.0 mm panel with 2 veneers and 10 mats. Wood veneer as faces and

mats as core. (72% replacement of wood).

Code No. 9 : 12.0 mm panel with 3 veneers and 4 mats. 2 wood veneers as face plies and 1 veneer as central glue core interspersed with equal number of mats on either side of core veneer. Grain direction of wood veneers being at right angles to the next veneer in the assembly. (40% replacement of wood).

Code No. 10 : 9.0 mm panel with 3 veneers and 2 mats. Bamboo mats as faces with wood veneers in the middle. Grain direction of wood veneer being at right angles to the adjacent veneer. (25% replacement of wood).

Code No. 11 : 14 mm panel with 3 veneers and six mats. One mat on either side of face interspersed with 2 mats in between veneers. Grain direction of veneers being at right angles to next veneer in the assembly. (50% replacement of wood).

Code No. 12 : 14 mm panel with 3 veneers and 6 mats. Wood veneer as face plies and also as centre ply of the panel interspersed with 3 mats on either side of core veneer. Grain direction of wood veneer being at right angles to each other in the veneer assembly. (50% replacement of wood).

Code No. 13 : 16 mm panel with 3 veneers and 8 mats. Wood veneers as face plies and also as centre ply of the panel interspersed with 4 mats on either side of the core veneer. Grain direction of wood veneers being at right angles to each other in the veneer assembly. (57% replacement of wood).

Code No. 14 : 19 mm panel with 3 veneers and 10 mats. Wood veneers as face plies and also as centre ply of the panel interspersed with 5 mats on either side of the core veneer. Grain direction of wood veneers being at right angles to each other in the veneer assembly. (63% replacement of wood).

Code No. 15 : 21 mm panel with 3 veneer and 12 mats. Wood veneers as face plies and also as centre ply of the panel interspersed with 6 mats on either side of the core veneer. Grain direction of wood veneers being at right angles to each other in the veneer assembly. (67% replacement of wood).

Code No. 16 : 16 mm panel with 3 veneers and 8 mats. 2 mats each as faces followed by veneer and 2 mats and central core as wood veneer. Grain direction of wood veneers being at right angles to each other in the veneer assembly. (57% replacement of wood).

Code No. 17 : 19 mm panel with 5 veneers and six mats. Mat as faces followed by veneer and a mat. Grain direction of wood veneers being at right angles to each other in the assembly. (37% replacement of wood).

Code No. 18 : 6 mm panel with 3 veneers of 2.4 mm thickness.

Code No. 19 : 12 mm panel with 5 veneers of 2.4 mm thickness.

Code No. 20 : 16 mm panel with 7 veneers of 2.4 mm thickness.

Hot Pressing Conditions : The resin coated mats and wood veneers were assembled on

aluminum cauls previously coated with silicone releasing agent and hot pressed at a temperature of 140° - 150°C and 1.6 MPa pressure for a period of 6 min. for 3 layered boards and 1 min. extra for every additional mm of thickness.

Testing of panels : Test specimens from bamboo mat boards, bamboo mat wood veneer composites and control plywood panels made from *Grevillea robusta* veneers manufactured in the Institute were conditioned to a moisture content around 10 per cent. Tests were statistically designed for a probability of 68.3% (one Sigma level) and an experimental precision of 3%. Minimum number of test specimens required for testing were determined from the coefficients of variation earlier established for various tests at this Institute. A recheck was also carried out to confirm the validity of these coefficients of variation. Specimens were tested as per relevant Indian Standard Specifications for different strength properties. Test results are summarized in Table 2.

Results and Discussion

Evaluation of physical-mechanical properties of bamboo mat board, bamboo mat-veneer composite and plywood panels from lesser known timber species revealed the following information :

1. Lower tensile strength, compressive strength, modulus of rupture and modulus of elasticity have been obtained for bamboo mat board. Low strength properties were expected as bamboo mat boards are made of layers of bamboo mat with herringbone type weave arranged in the same direction with respect to weave pattern unlike plywood, which has cross grained layered construction.

2. Introduction of wood veneer in the panel has increased all the properties considerably except modulus of rigidity depending on the number of veneers and their position in the assembly and also grain direction of adjacent veneers. Though modulus of rigidity of composite panels has come down considerably as compared to the values obtained for bamboo mat boards, the composite panels have still much higher modulus of rigidity (4 to 9 times) than the values prescribed for structural plywood.

3. Density of bamboo mat - wood veneer composite panels is comparable with bamboo mat boards. However density of these boards is higher when compared to the values of control panels made by using veneers of *Grevillea robusta*.

4. Considering the strength values of composite panels and manufacturing aspects, it is desirable to manufacture panels using veneer as face plies and mid-core interspersed with bamboo mats equally on either side.

5. Strength properties of plywood panels made entirely of wood veneers from *Grevillea robusta* are very low and do not conform to the requirements prescribed in the specification for structural plywood.

6. There is scope to carry out further work by changing the assembly pattern and substitution of wood veneers by bamboo mats to the maximum possible in the manufacture of composite panels so that the strength properties meet the requirements prescribed in Indian Standard Specification for structural plywood.

Table

Physical-Mechanical Properties of Bamboo Mat Boards, comparison with relevant

Panel code No.	Construction Thickness (mm)	Replacement of wood(%)	Density of panel (kg/m²)	Int Bond strength Dry M.Pa	Int Bond strength Wet M.Pa	Surface strength Dry M.Pa	Surface strength Wet M.Pa	Tensile strength Along M.Pa	Tensile strength Across M.Pa
1	2	100	751	2.23	1.79	12.14	11.01	-	-
2	3	100	766	2.18	1.98	11.42	11.42	22.69	22.63
3	6	100	771	2.42	2.14	11.23	10.47	26.59	26.53
4	8	100	790	1.97	1.73	9.47	9.10	29.54	29.54
5	4	50	713	2.15	1.81	12.65	10.25	47.75	17.20
6	6	67	747	2.12	1.41	12.55	8.28	42.20	19.35
7	19	75	827	2.36	1.70	14.20	10.00	38.40	26.10
8	16	72	783	2.28	1.84	13.80	11.00	41.60	22.80
9	12	40	708	2.14	1.55	12.65	9.05	50.20	29.30
10	9	25	654	2.00	1.45	12.03	8.15	45.90	28.85
11	14	56	704	2.00	1.70	11.98	9.40	49.70	33.70
12	14	50	762	2.16	1.75	12.40	9.90	44.90	31.40
13	16	57	760	1.96	1.54	11.80	8.80	34.80	32.50
14	19	63	752	2.20	1.80	13.50	10.68	41.90	33.40
15	21	67	802	2.30	1.65	13.80	9.80	36.40	35.80
16	16	57	762	1.34	1.06	8.00	6.80	43.00	32.60
17	19	37	710	1.93	1.35	11.48	7.75	41.95	34.40
18	6	0	590	1.75	1.60	10.60	9.50	38.30	25.30
19	12	0	583	1.83	1.50	11.00	8.50	33.30	32.80
20	16	0	553	1.78	1.45	10.80	8.60	32.70	33.80
Requirements as per I.S. 13958 - 1994 Specification for Bamboo Mat Board for General Purpose			Avg.	0.70	0.5	4.5	3.00		
			Min.	0.50	0.30	3.00	2.00		
Requirements as per Draft Standard for Bamboo Man-Veneer Composites.			Avg.	1.50	1.20	9.00	7.00		
			Min.	1.20	0.90	7.00	5.00		
Requirements for structural plywood as per IS:10701-1983						Avg.		54.00	34.00
						Min.			
Requirements for Concrete Shuttering Plywood as per IS:4990-1993						Avg.		32.50	22.50
						Min.		Sum	60.00
Requirements for marine plywood as per IS:710-1976						Avg.		42.00	25.00
						Min.		Sum	84.50
Requirements for BWR grade general purpose plywood as per IS:303-1989						Avg.			
						Min.			

2

Bamboo Mat-Veneer Composites and Plywood Panels in Indian Standard Specifications

Comp. Strength		Mod. of Rupture		Mod. of Elasticity		Mod. of Rigidity	Glue shear strength	
Along M.Pa	Across M.Pa	Along M.Pa	Across M.Pa	Along M.Pa	Across M.Pa	M.Pa	Dry N	Wet N
-	-	-	-	-	-	5401	-	-
16.77	16.77	50.74	50.74	3670	3678	5881	-	-
30.35	30.35	56.31	56.31	3220	3220	6050	-	-
35.30	35.30	59.35	59.35	3114	3114	6066	-	-
40.40	22.55	76.35	63.95	4350	3750	4920	-	-
41.45	34.80	67.25	62.55	3950	3625	5433	-	-
47.10	42.60	59.90	55.60	6740	3730	3240	-	-
49.20	38.30	72.40	35.10	7750	2240	2282	-	-
43.40	34.80	75.65	44.10	5725	3015	3135	-	-
35.00	27.75	75.55	46.15	5665	3220	3185	-	-
41.10	31.10	74.60	41.60	6870	2800	3425	-	-
49.40	41.30	65.70	38.50	7570	2420	2309	-	-
43.20	34.70	72.20	39.30	8030	2410	2324	-	-
45.70	36.30	72.70	42.40	7400	2620	2490	-	-
43.30	40.20	68.50	55.40	7820	3210	3316	-	-
44.50	37.30	66.30	48.20	5600	3450	4407	-	-
40.95	33.85	65.90	51.85	5670	3575	2768	-	-
23.70	18.20	52.70	13.70	6060	597	630	1080	1270
22.80	19.50	47.70	29.40	5760	2200	624	1230	1220
24.90	20.50	47.70	30.00	5690	2560	600	1190	1100
34.00	29.00	49.00	29.00	7355	3923	588	1350 1100	1000 800
				8000	4000	588	1350 1100	1000 800
							1350 1100	1000 800
							1350 1100	1000 800

Conclusion

Based on the investigation carried out at the Institute, it is possible to manufacture high strength bamboo mat - wood veneer composite panels which has immense potential for structural/constructional uses. There is ample scope to substitute wood veneers to the extent of 50-60% and improve the strength properties by changing the veneer - mat assembly pattern in the manufacture of composite panel so that it matches with the requirements prescribed in Indian Standard Specification for Structural Plywood.

Acknowledgements

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SUMMARY

In view of decline in wood supplies, interest is growing on substituting wood. Results of the investigations carried out to substitute wood partially in plywood, a preferred panel due to its superior physical-mechanical strength properties, with bamboo mat are reported in this paper. Investigations have indicated that strength of a panel made by using plantation timber such as *Grevillea robusta* has been substantially enhanced when made in combination with bamboo mat. Physical-mechanical properties of such composite panels could be compared with the properties of special purpose plywood such as marine plywood and shuttering plywood. There is scope for further work to bring such thicker composite panels on par with special purpose plywoods like structural, marine, shuttering etc., by adopting optimum construction with veneers and bamboo mats. Manufacture of thicker panels using only bamboo mats was not an economical proposition hitherto. The present investigation has revealed that thicker panels can be manufactured economically using bamboo mats in combination with wood veneers. Details with respect to the manufacture of composite panels such as resin, resins and adhesive composition, application of adhesives, panel construction, hot pressing schedules are briefly described.

काष्ठ के स्थानापन्न रुप में बांस चटाई - काष्ठ-परत संग्रथों का विकास

बी०एन० राजीव, एम०वी० नायडु, टी०एस० रंगराजु, एस०एस० जुलागुड व बी०एस० अश्वत्थनारायण

सारांश

काष्ठ पदाय में कमी होते जाने के कारण काष्ठ के स्थानपन्नों में रुचि बढ़ रही है । काष्ठ की जगह अंशतः स्तरकाष्ठ, जो अपनी श्रेष्ठतर भौत-संधारी शक्ति विशेषताओं के कारण पसन्द किया जाने वाला एक फलक है, के साथ बांस की चटाई मिलाकर उसका स्थानापन्न तैयार करने के अन्वेषणों को इस अभिपत्र में बताया जा रहा है । अन्वेषणों से संकेत मिला है कि रोपवन में उगाए प्रकाष्ठ जैसे रजत बंजु से बनाए फलक की शक्ति से उसे बांस की चटाई के साथ मिलाकर उपयोग में लाने पर काफी बढ़ जाती है । ऐसे संग्रथित फलकों की भौत-संधारी शक्तियों की तुलना विशेष प्रयोजनों के लिए बनाए स्तरकाष्ठ जैसे समुद्री स्तरकाष्ठ और शटर बनाने का स्तरकाष्ठ से सहज ही की जा सकती है । अन्य विशेष प्रयोजनों के स्तरकाष्ठ जैसे संरचनात्मक, समुद्र शटरिंग आदि के लिए इष्टतम निर्माण द्वारा तुलनीय अधिक मोटे संग्रथित फलक परत और बांस की चटाई प्रयोग करके बनाने के लिए भी गुंजाइश है । केवल बांस चटाई उपयोग में लाकर अधिक मोटे फलक तैयार करना अभी तक आर्थिक दृष्टि से लाभप्रद नहीं हो पाया था । प्रस्तुत अन्वेषण से पता लगा है कि बांस चटाइयों को काष्ठ-परतों (वेनियरों) के साथ मिलाकर मोटे फलक बनाना भी आर्थिक दृष्टि से लाभप्रद रह सकता है । संग्रथित फलक बनाने विषयक अन्य विस्तृत ब्यौरे जैसे लीसा, अभिलागी की रचना, लीसा और अभिलागीयों का उपयोग, फलक निर्माण, गरम दबाव की तालिकाएँ भी संक्षेपतः बताई गई हैं ।

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RAINFALL PATTERNS IN DOON VALLEY, INDIA

LAXMI RAWAT AND VIJAY RAWAT

Ecology and Environment Division,
Forest Research Institute, Dehra Dun (India)

Introduction

Rainfall has always been considered one of the most important parameters of climate of a place. The four seasons in the Indian subcontinent are recognised on the basis of rainfall only, which are :

(1) Winter; from December to February,
(2) Summer or Pre-monsoon; from March to May,
(3) South-West monsoon; from June to September, and
(4) Post-monsoon; from October to November.

The most important factor responsible for rainfall in the Doon Valley is its unique physiography. A sharp rise in Himalayan ranges of Mussoorie hills commences from the Doon Valley and reaches about 2400 m at Landour. This results in a significant hindrance to the movement of monsoon winds resulting in heavy rainfall in the valley.

In the present article the course of annual monthly and seasonal rainfall has been discussed along with its variability, intensity and frequency over a period of 60 years (1931-1990).

Study Site

Doon Valley is 640 m above msl. It is situated between 30° 19' 55" and 30° 21' 16" North latitude and 77° 58' 40" and 77° 1' East longitude. The study site New Forest lies North of Dehra Dun.

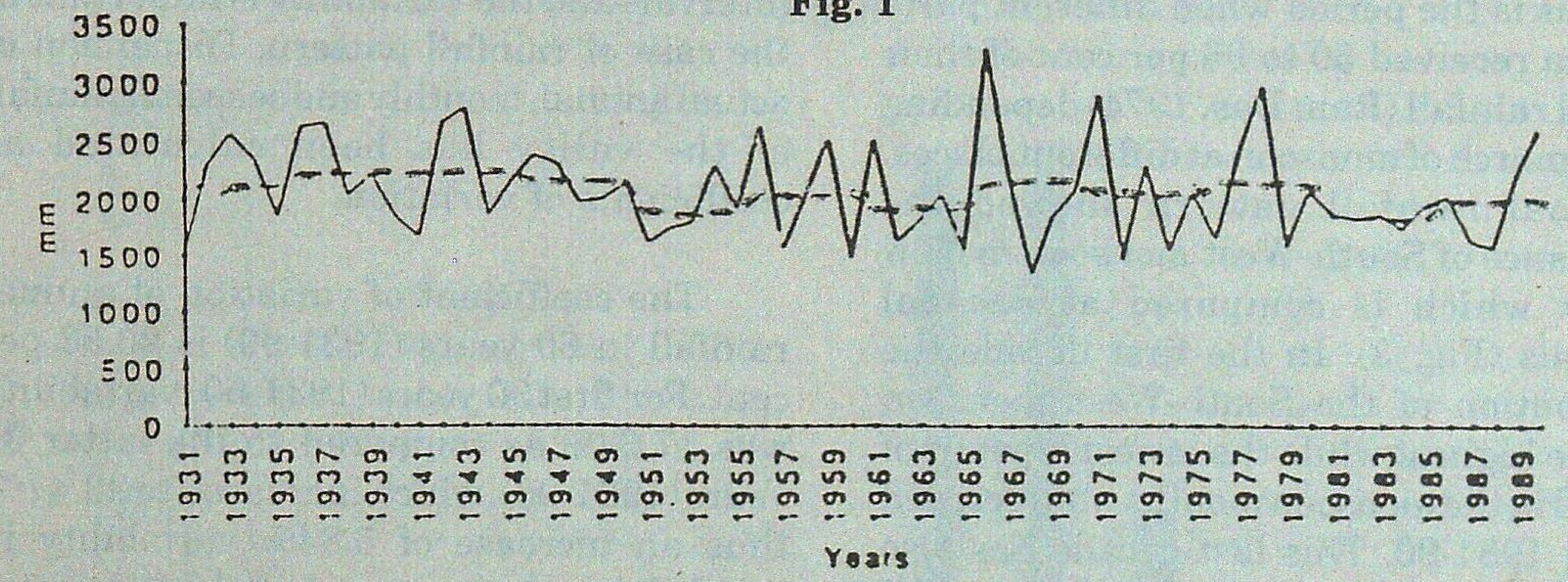
Materials and Methods

The daily rainfall data was recorded in the New Forest Meteorological Observatory of Forest Research Institute (FRI), Dehra Dun, since 1931. Standard Symons Rainguage (Sym) and Self Recording Rainguage (SRG Type) are used for daily rainfall recording.

Results and Discussion

Annual Rainfall : The annual rainfall of New Forest (Doon Valley) for past 60 years (1931-90) is shown in Figure 1 along with 5 yearly mean values. As is evident from the figure the annual rainfall shows a swinging pattern with maximum rainfall occurring during the year 1966 (3306 mm), the other peaks in annual rainfall are observed in 1978 and 1971 (2968.9 and 2898.4 mm, respectively). The lowest annual rainfall was recorded in 1968 (1331.9 mm) followed by 1972 (1400.8 mm). On an average the annual rainfall in past 60 years was recorded as 2069 mm. When compared with annual rainfall at decadal intervals, the highest annual rainfall was recorded during the decade 1941-50 and the lowest in decade 1981-90 (Table 1). The annual rainfall has

Fig. 1



Annual Rainfall for last 60 years. The 5 yearly average rainfall is shown as dashed line

decreased in the latter half of 30 years (1961-90).

Table 1

Annual rainfall at decadal intervals and two blocks of 30 years

Years	New Forest
1931-40	2195.3 ± 110.93
1941-50	2200.62 ± 110.84
1951-60	1962.5 ± 129.12
1961-70	2031.38 ± 178.45
1971-80	2091.29 ± 177.81
1981-90	1926.18 ± 95.12
1931-60	2195.5 ± 68.23
1961-90	2015.9 ± 87.51

Monthly : The average monthly rainfall pattern over past 60 years showed that the months of January, February, March, April and May received very little amount of rainfall ranging between 1.01 per cent in April to 2.75 per cent in February, month of June received only 9.6 per cent of annual rainfall. Month of June normally remains dry and the South-West monsoon reaches in the valley only in the last week of June. July and August received the highest amount of rainfall during the year which accounted for 30.1 and 31.1 per cent, respectively. September being the month of retreating monsoon and accounted for 13.7 per cent of annual rainfall. October and November are the post monsoon months and accounted for only 2.55 and 0.4 per cent of annual rainfall, respectively. December also received a very low percentage (1.38 per cent) of annual rainfall. July and August received the maximum of 1228.3 mm and 1321.3 mm of rainfall in 1946 and 1947 as against monthly average of 623.6 and 654.5 mm, respectively. January, February, March, April, May, October, November and December received no rainfall during many years.

The quantity of average monthly amounts of rainfall received in Doon Valley for the year 1931-60 and 1961-90 is drawn in the Fig. 2. It clearly shows that monthly rainfall for latter 30 years is lower in almost every months than monthly rainfall of earlier 30 years, except during summer months which accounted negligible amount of annual rainfall.

Seasonal : South-West monsoon dominates the entire country from June to September

and this is the period when different parts of India received 50 to 96 per cent of their annual rainfall (Ram Das, 1974) depending on the march of monsoon at different places. Seasonal rainfall pattern showed the dominance of South-West monsoon in New Forest which is compared at decadal intervals (Fig. 3). In the first decade the contribution of the South-West monsoon was the highest while the lowest amount of rainfall in the monsoon months was recorded during 1981-90. This last decade has also shown the lowest amount of annual rainfall in the valley.

Table 2

Average seasonal rainfall - New Forest (figures are as % of annual rainfall)

Years	Winter	Summer	Monsoon	Post-monsoon
1931-60	6.86	4.54	84.66	3.91
1961-90	6.50	6.05	85.13	2.13
1931-90	6.69	5.28	84.89	3.14

The annual average contribution of summer monsoon during 1931-60, was 84.66 per cent to the average annual rainfall of 1931-60. The corresponding figures for 1961-90 was 85.13 per cent (Table 2).

Variability : The increasing realization that variability must be accepted as an inherent character of climate (Anon, 1976) has focussed attention on need to describe and document climatic variability on a wide range of time scales, such information act as prerequisite to an understanding of climatic system and to the development of reliable climatic models.

Rain does not actually occur at regular intervals and the variability is important in the case of rainfall pattern. Dispersion of actual annual, monthly and seasonal rainfall of the valley has been calculated as coefficients of variation.

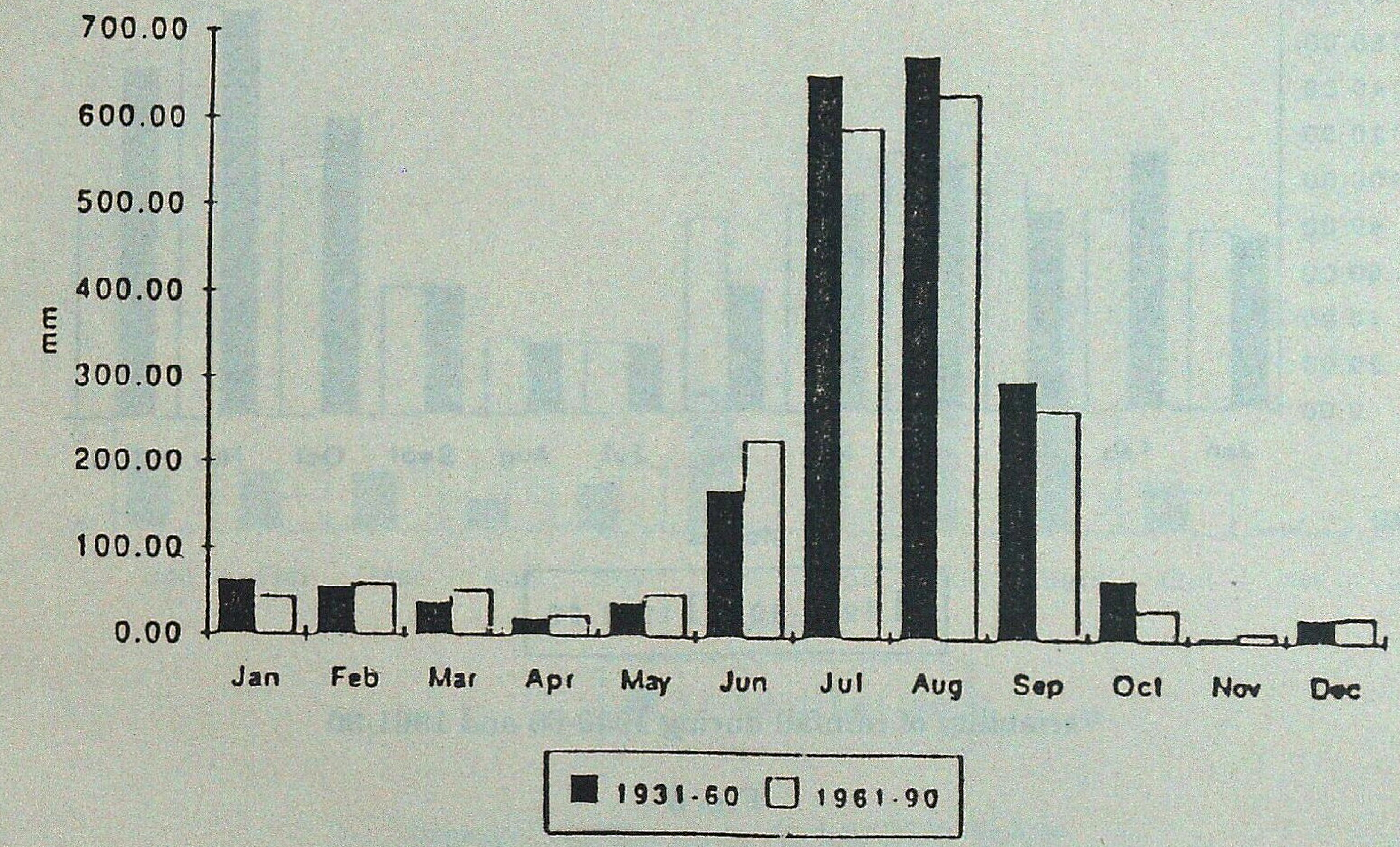
The coefficient of variation of annual rainfall in 60 years (1931-90) is 20.53 per cent. For first 30 years (1931-60) variability was 17.63% as compared to the latter 30 years (1961-90), which increased to 23.47%, thus an increase of 5.84% variability in rainfall has been recorded during latter 30 years.

Monthly and Seasonal : The salient features of monthly and seasonal variability in Doon Valley are shown in Figs. 4 and 5. The magnitude of both absolute and relative rainfall variability on the basis of these shorter units of time entirely differs from that of annual rainfall. Coefficients of variation are negatively correlated with average rainfall amounts over the months and seasons.

Throughout the study period coefficients of variation are lowest during South-West monsoon periods and it varies from 39.4% (1981-90) to 62% (1961-70). The variability during South-West monsoon over 60 years period (1931-1990) is 47.5% and the corresponding values for the period 1931-40, 1931-60 and 1961-90 are 41.5, 49.9 and 51.2%, respectively. The outstanding amplitudes for the period (1931-90) are recorded between seasons of South-West monsoon and post-monsoon (47.54 and 149.1%). Post-monsoon season recorded greatest coefficients of variation followed by summer season.

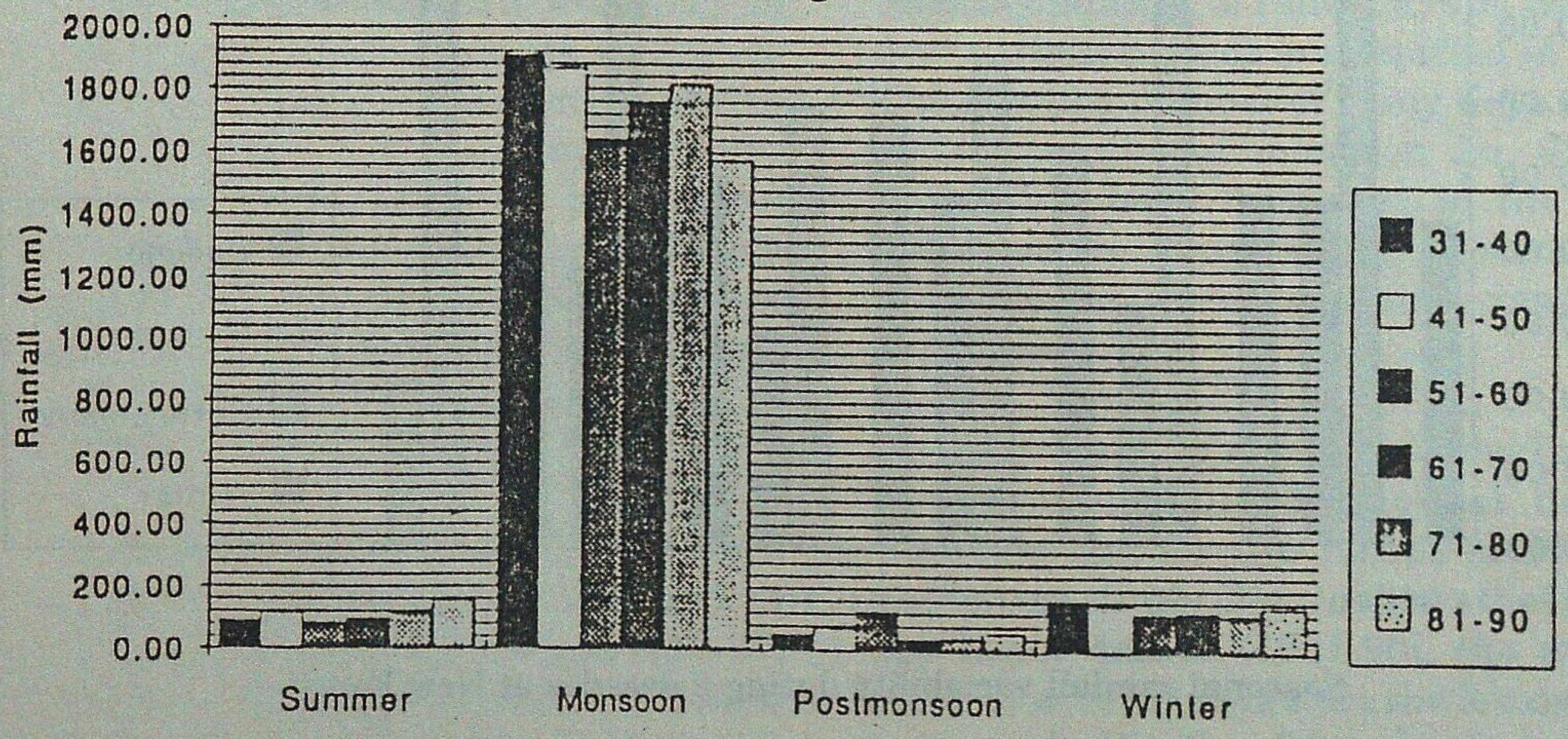
The greater part of Monsoon Asia is known as one of the rainiest regions of the

Fig. 2



Average monthly rainfall during 1931-60 and 1961-90

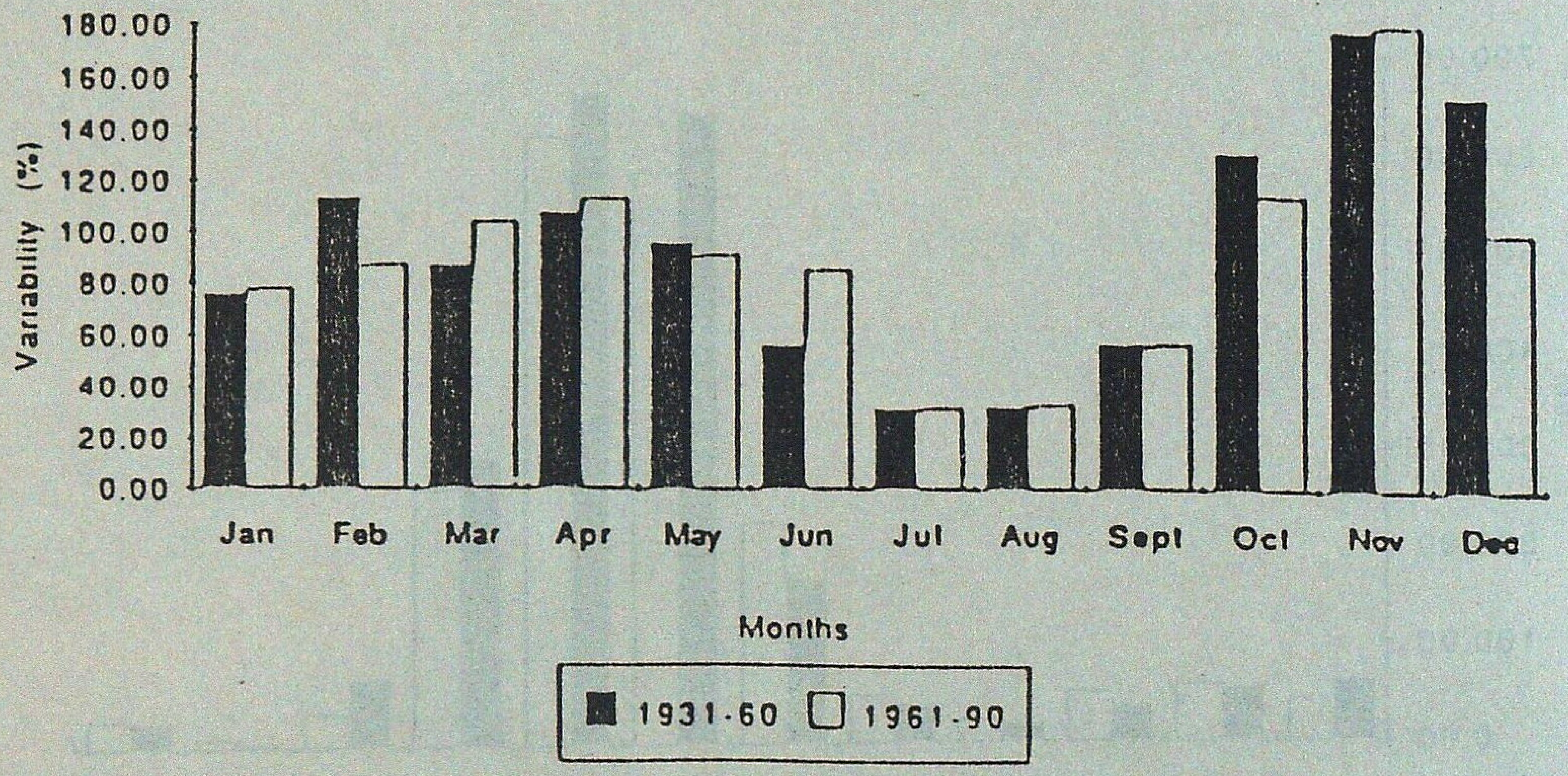
Fig. 3



Seasonal rainfall during 6 decades at New Forest

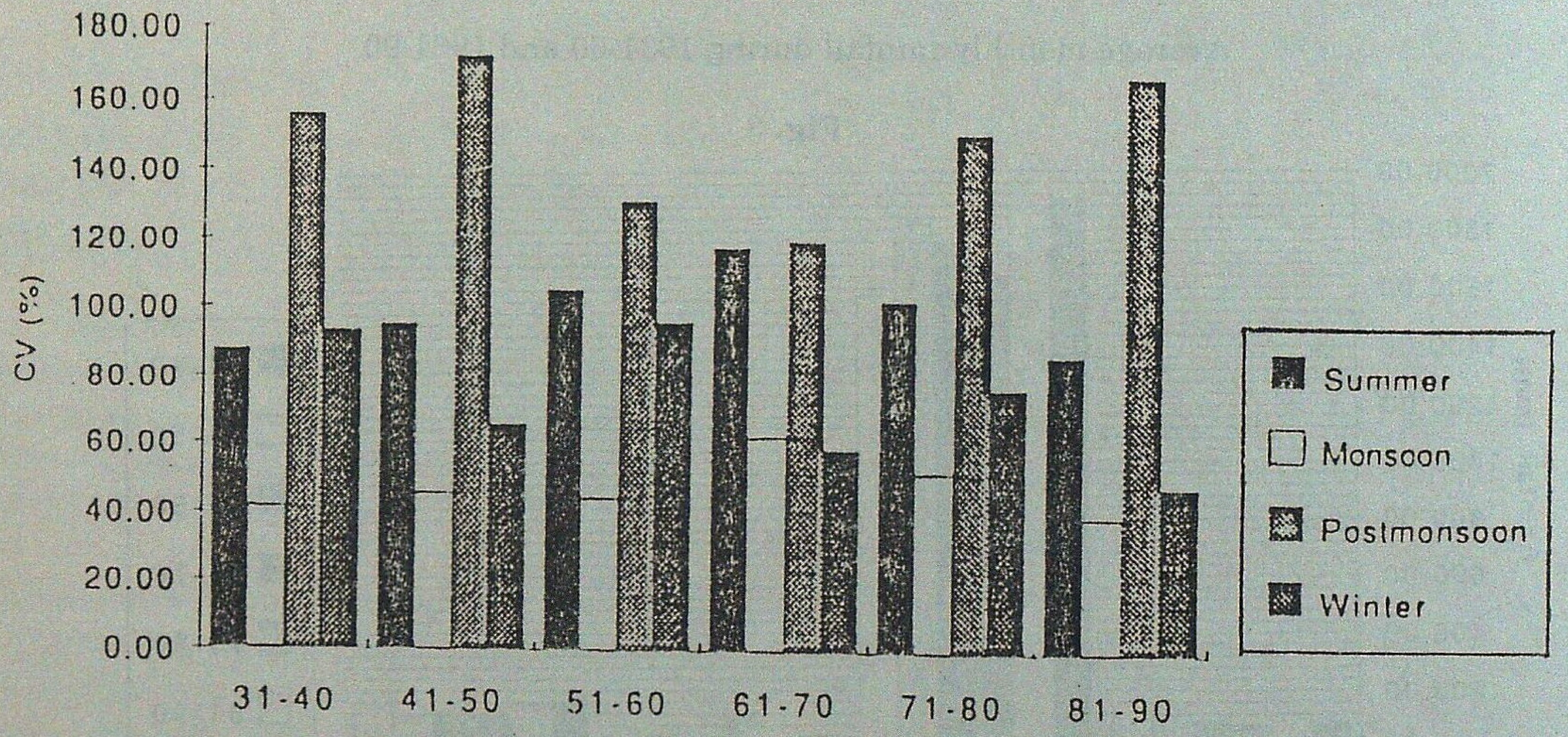
world (Hatakerjama, 1964). But the map of relative variability in annual precipitation given by Koppe and de Long (1958) shows that this area has a greater variability than any other region with nearly the same annual precipitation. This situation seems to be produced by alternation of relative dry years with humid air in Monsoon Asia

Fig. 4



Variability of rainfall during 1930-60 and 1961-90

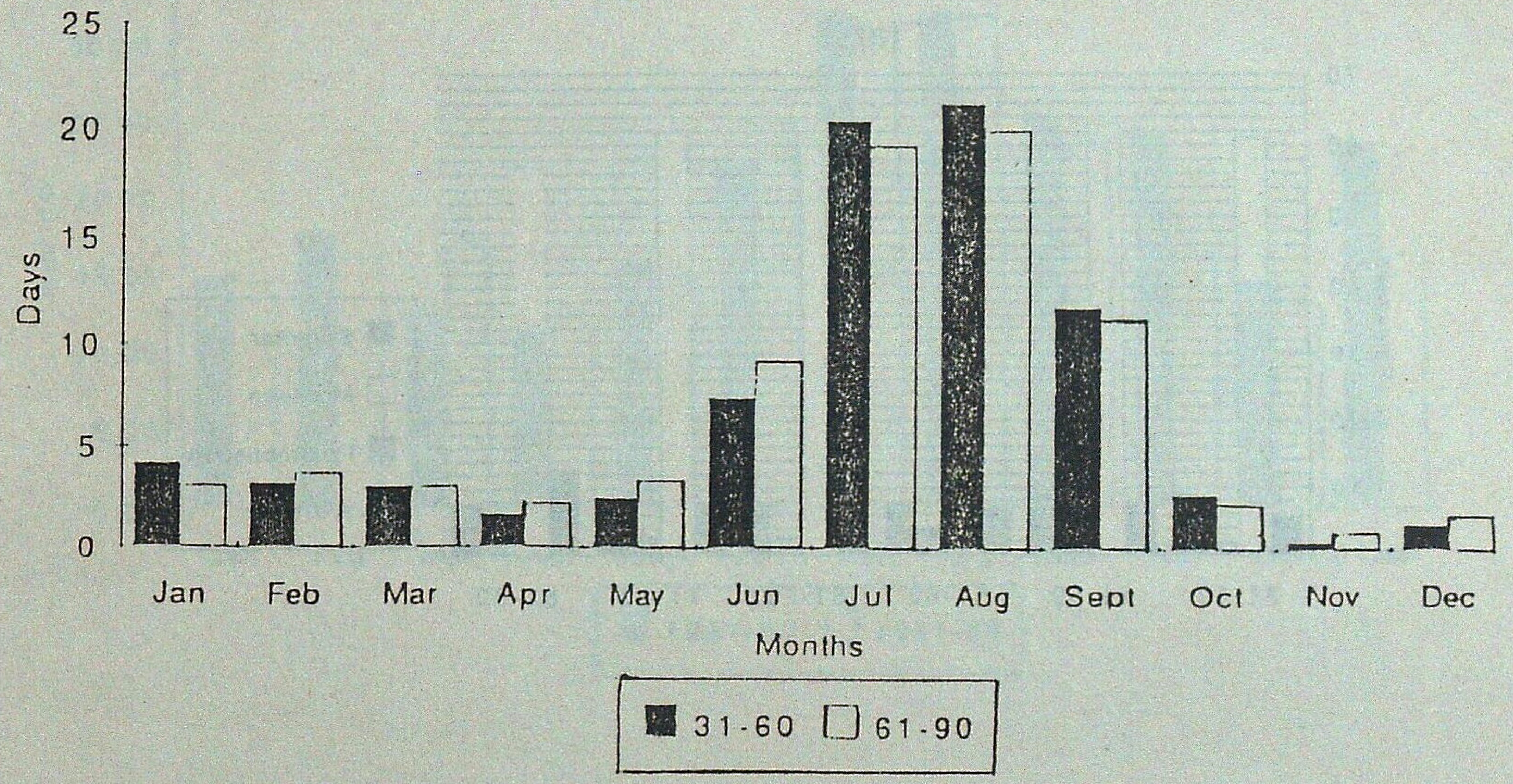
Fig. 5



Seasonal rainfall variability during 6 decades at New Forest

(Yoshimura, 1971). As a result of detailed statistical analysis of much longer period data on rainfall in India, Pramanik and Jagannathan (1953), reported that there is no general tendency of increase or decrease in any particular area in rainfall variation in India. Rao (1964) is of the opinion that in this region variability of South-West monsoon rainfall is the factor regulating year to year rainfall variation.

Fig. 6



Average monthly rainy days at New Forest

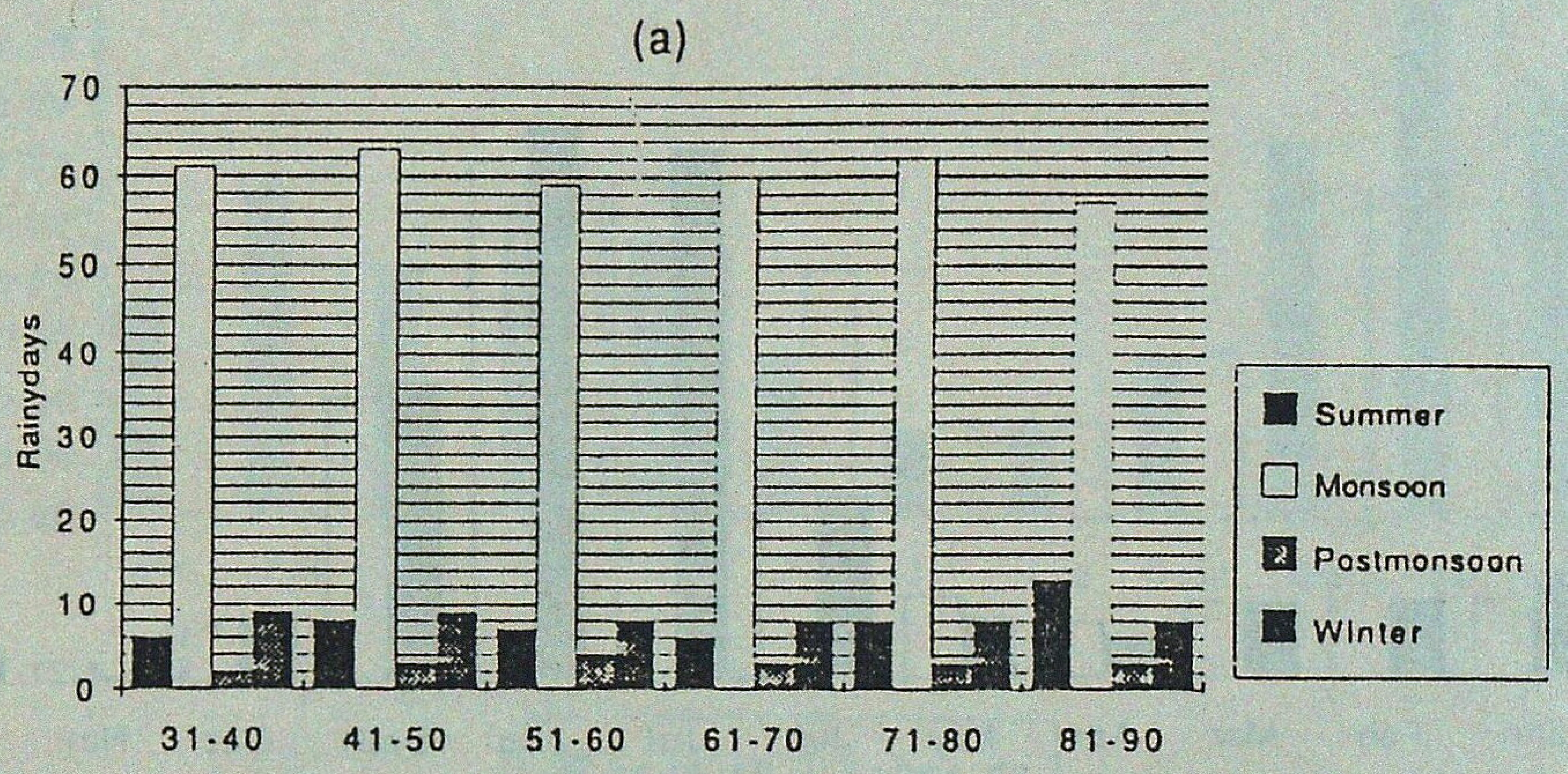
Rainfall Frequency : From the point of view of moisture availability, the efficiency of rainfall largely depends on its frequency and intensity. The most common parameter used is the number of 'rainy days' per unit period of time. In India as per Indian Meteorological Department standards this is defined as number of days with 2.5 mm of rainfall or more. The 'day' refers to 24 hours between two observations made at 0730 hours Indian Standard Time (IST).

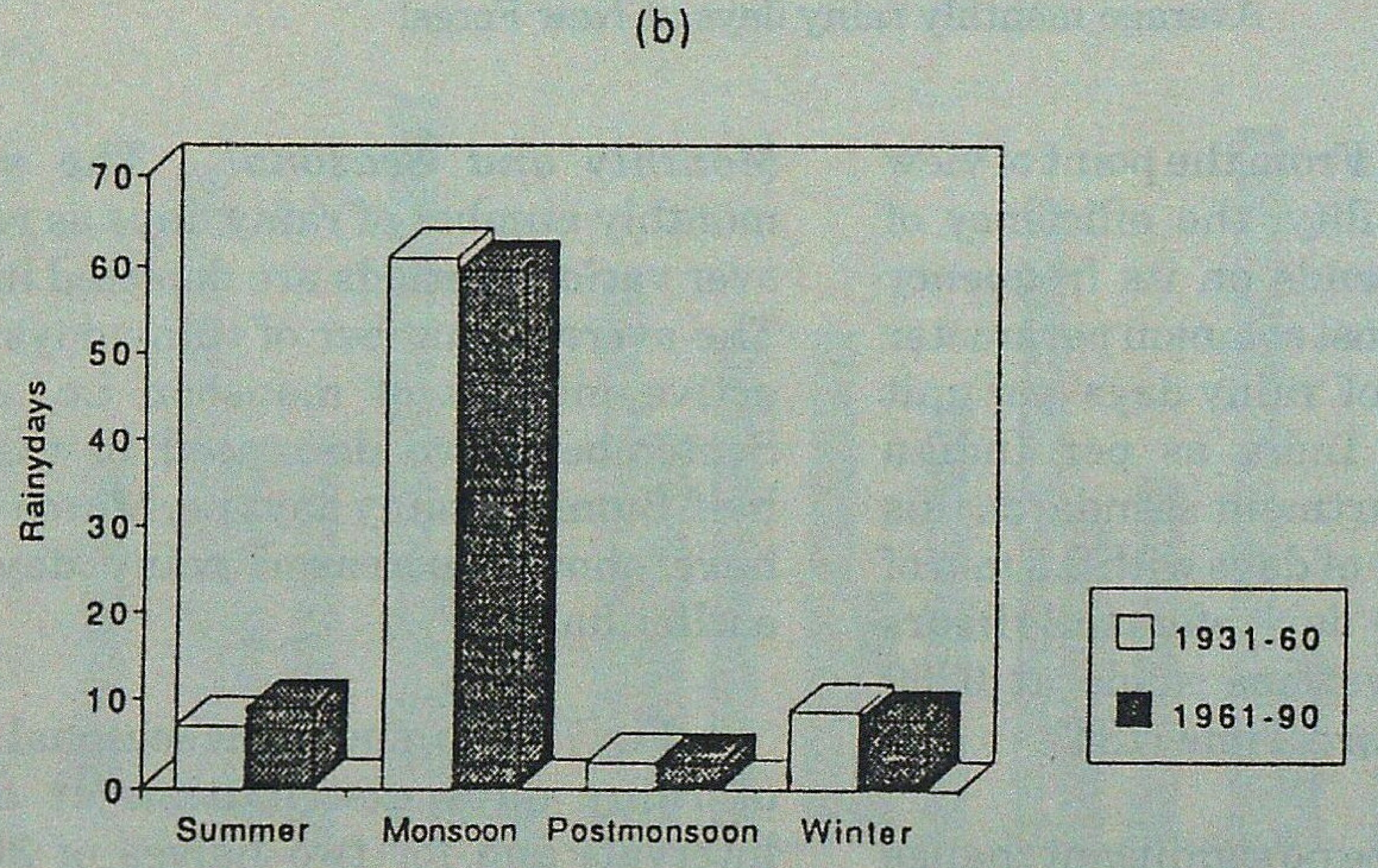
There seems to be no significant change in average annual number of rainy days as they are equal during 1931-60 and 1961-90. Even during whole study period (60 years) this number is the same (80 days). However, the variability in the number of rainy days during last 30 years (1961-90) was higher (C.V. 12.36%) as compared to that of during earlier 30 years, which is 11.66%.

Monthly and Seasonal : The average monthly number of rainy days as recorded over various periods are depicted in Fig. 6. The average number of rainy days during active months of monsoon i.e. July to September have decreased in the latter half. Summer rainy days i.e. March to June have shown increased rainy days than earlier half.

Fig. 7 (a & b) shows the seasonal pattern of rainy days distribution at decadal intervals and for two halves of 30 years each, respectively. Fig. 7a shows that during the latest decade (1981-90), the average number of rainy days were the lowest when compared with other 5 decades, but number of rainy days during summer months have increased. Number of rainy days during two halves of 30 years showed that this number has decreased in South-West

Fig. 7 (a & b)





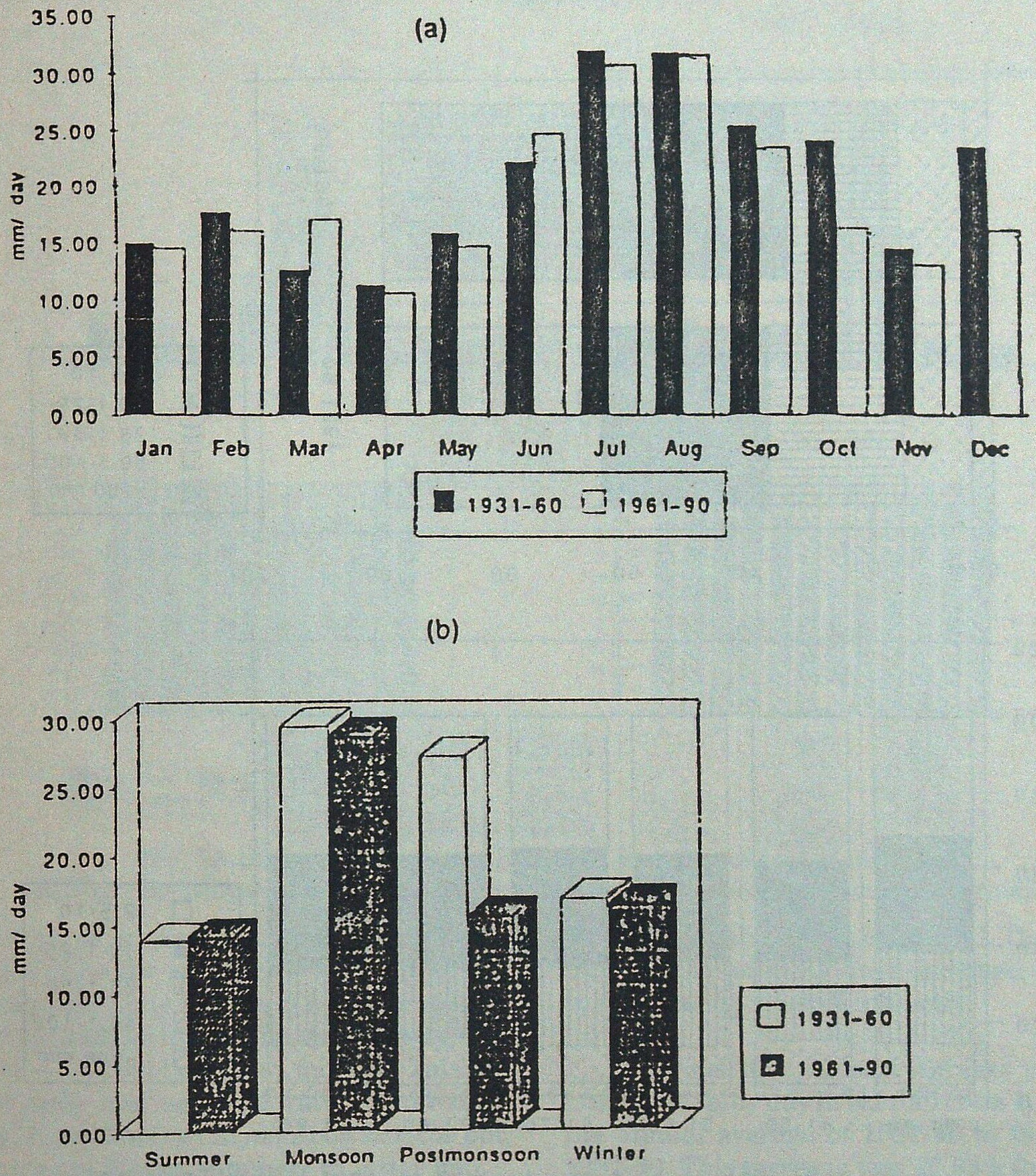
Seasonal rainy days at New Forest

(a) during 6 decades and (b) during 1931-60 and 1961-90

monsoon period while rainy days in summer period have increased in the latter half (Fig. 7 b).

Rainfall Intensity : Rainfall concentration or intensity is defined as amount of rainfall per unit period of time. The magnitudes of annual, monthly and seasonal rainfall have already been described but since rain falls on far less than 1/3rd of the days of a year,

Fig. 8

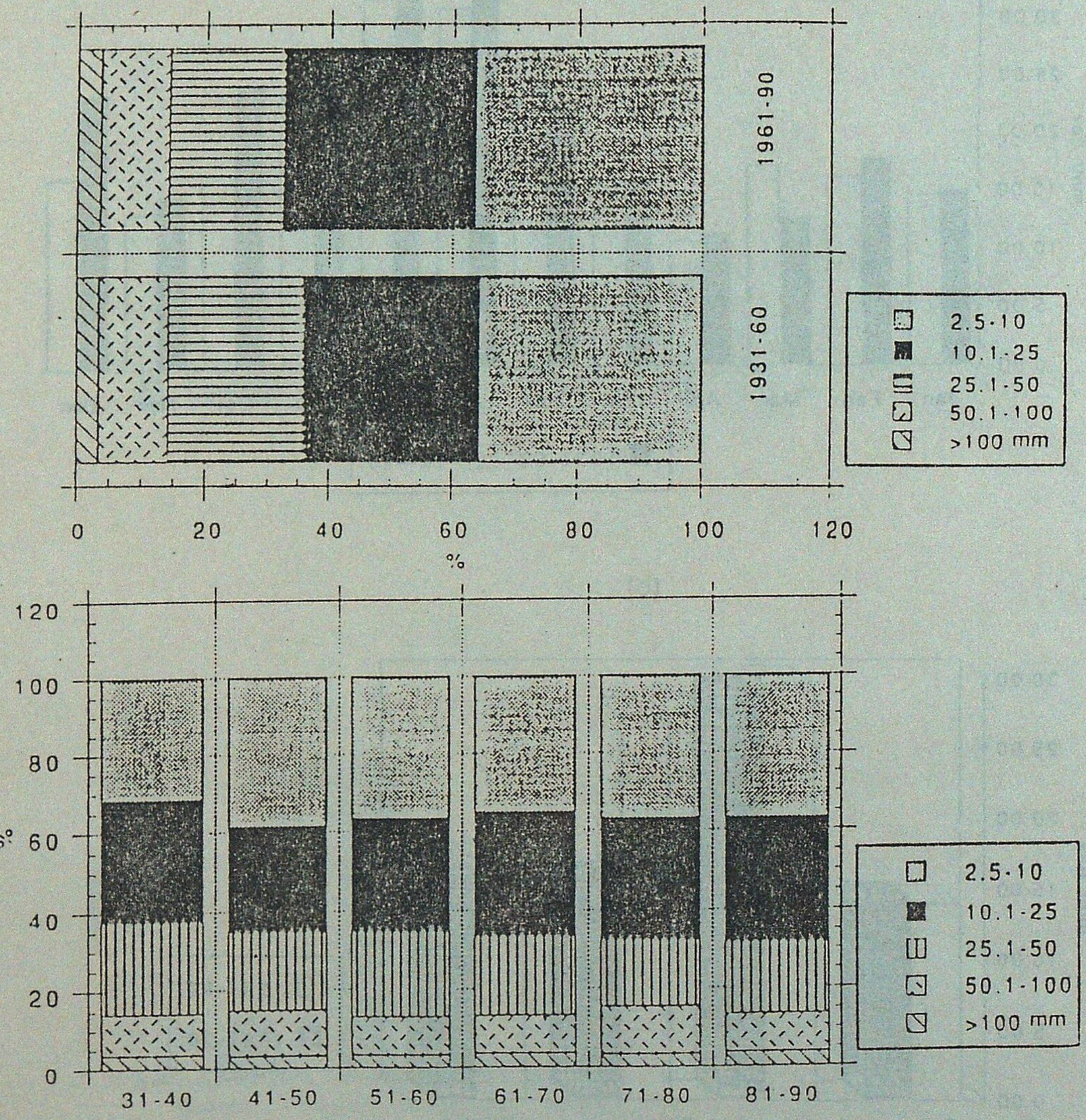


Rainfall Intensity at New Forest
(a) monthly and (b) seasonal

they can only be considered as crude indicators. A more refined realistic parameter is the rainfall amount received per 'rainy day'.

Annual : Annual rainfall intensity during different decades of the period showed highest (28.07 mm/ day) during 1931-40 and lowest during 1981-90 (23.55 mm/ day). The annual intensity of rainfall for first 30 years was 26.58 mm/ day which decreased to 25.2 mm/ day during latter 30 years.

Fig. 9 (a & b)

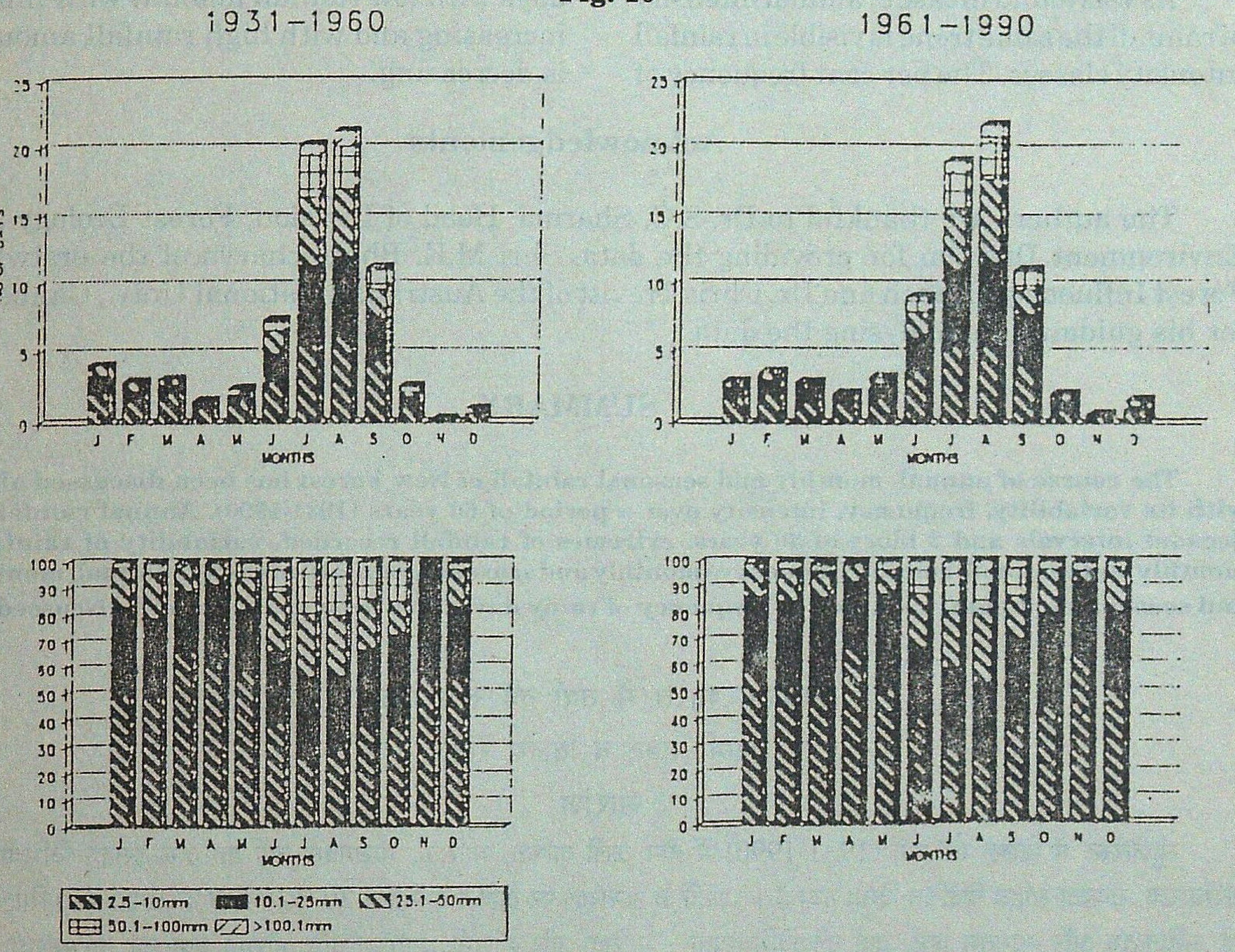


Annual percentage frequency of rainy days with specified amounts of rainfall
Top : during 1931-60 and 1961-90
Bottom : at decadal intervals

Thus decrease of 5% from average of earlier to latter half of 30 years has been recorded. Annual rainfall intensity during whole period of 60 years was recorded as 25.92 mm/day.

Monthly and Seasonal : Monthly and seasonal intensity of rainfall in these two halves has been shown in Fig. 8 (a & b). As observed in case of monthly rainy days too the monthly rainfall intensity during active

Fig. 10



Top : Monthly number of rainy days with specified amount of rainfall.
Bottom : Monthly percentage frequency of rainy days with specified amounts of rainfall

months of monsoon showed a decreasing trend from the averages of first half to the latter half. Only months of March and June have shown an increasing trend during this period. As evident from monthly rainfall intensity and seasonal rainfall intensity too, it has lowered in monsoon months but increased during summers in latter half.

In order to get more precise data on rainfall intensity Fig. 9 a and b can be seen. The two sets of diagrammes present various aspects of a detailed analysis of rainfall records over 60 years. The rainfall data is analysed by assigning 5 rainfall intensity classes. The highest per cent of rainy days accounted for lowest rainfall intensity class (2.5-10 mm rainfall per rainy day). The per cent number of rainy days decreases with the increasing rainfall intensity.

There is 13.8 per cent increase in the number of rainy day in rainfall class 1, from the annual average of 1931-40 to that of 1931-90. This increase was 12.53% for the period 1931-60 and 15.09% for 1961-90. During these periods this change was insignificant with rainfall frequency class 4 (Coefficient of Variation 0.6%). The per cent number of rainy days with rainfall frequency class 5, decreased to 5% from the average of 1931-40 to that of 1931-90. This change was 15.4 and 18.6 per cent, respectively, for the periods of 1931-60 and 1961-90.

As was found in case of annual intensity of rainfall the same trend is visible in rainfall intensity classes. The per cent frequency of days with low rainfall amount with time is increasing and with high rainfall amounts is decreasing.

Acknowledgements

The authors are thankful to Dr. S.C. Sharma, Head of Division, Forest Ecology and Environment Division for providing the data, Shri M.K. Bhattacharya of the erstwhile Forest Influences Branch and Dr. Chris Trevitt of the Australian National Univ., Canberra for his guidance in analysing the data.

SUMMARY

The course of annual, monthly and seasonal rainfall of New Forest has been discussed along with its variability, frequency, intensity over a period of 60 years (1931-1990). Annual rainfall at decadal intervals and 2 blocs of 30 years, extremes of rainfall recorded, variability of rainfall - monthly and seasonal; rainfall frequency - monthly and seasonal, rainfall intensity - annual, monthly and seasonal; temporal variation of frequency of rainy days have been analysed and discussed.

दूनघाटी, भारत में वर्षा की रूपसज्जा

लक्ष्मी रावत व विजय रावत

सारांश

न्यूफोरेस्ट में पिछले 60 वर्षों (1931-1990) में होने वाली वार्षिक, मासिक, मौसमवार वर्षा का क्रम इसकी विभिन्नीयता, बारम्बारता, चण्डता सहित विवेचित किया गया है। दशकों के अन्तराल पर वार्षिक वर्षा तथा 30-30 वर्षों के दो खण्डों में अभिलिखित हुई अधिकतम और न्यूनतम वर्षा, वर्षा की विभिन्नीयता - मासिक और मौसमी, मासिक और मौसमी वर्षा की बारम्बारता, वर्षा की चण्डता-वार्षिक, मासिक और मौसमी, वर्षा होने वाले दिनों की समयगत विभिन्नयता का विश्लेषण और विवेचन किया गया है।

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MICROPROPAGATION TECHNOLOGY OF *BAMBUSA BAMBOS* THROUGH SHOOT PROLIFERATION

SARITA ARYA AND SUSHMA SHARMA

Tissue Culture Laboratory,
Division of Genetics and Tree Propagation,
Forest Research Institute, Dehra Dun (India)

Introduction

Micropropagation of tree species offers a rapid means of producing clonal planting stock for afforestation, woody biomass production and conservation of elite and rare germplasm (Bonga and Durzan, 1982; Bajaj, 1986; Arya and Shekhawat, 1986; Rathore *et al.*, 1991). A number of Bamboo species including *Bambusa arundinacea* are of considerable economic and social importance which need a method for large scale propagation. The conventional methods of propagation, both sexual as well as vegetative, have problems for number of reasons; production of seed is irregular with short viability, large scale consumption of seeds by wild animals, seed sterility, poor seed setting during off season, flowering and flowering once before culm death (McClure 1966; Janzen, 1976; Nadgir *et al.*, 1984). With respect to vegetative propagation, cuttings, offsets and rhizomes are bulky and non-available in required number, they are difficult to handle and transport, and plantlet survival is also usually low (Hasan, 1980).

Recently attempts have been made to micropropagate Bamboos, however plants have been recovered in small number in few Bamboo species through somatic embryogenesis (Rao *et al.*, 1985; Yeh and Chang, 1986 a, b; 1987) organogenesis (Huang *et al.*, 1989) and axillary branching (Nadgir *et al.*, 1984; Saxena, 1990). The present paper describes successful micropropagation and field transfer of *Bambusa arundinacea* through enhanced axillary bud proliferation, and its *in-vitro* flowering behaviour.

Materials and Methods

Explant source : Young and juvenile shoots were collected from nursery raised three year old plants. Nodal segments with single axillary buds were used as source material. The axillary buds were first washed with 5% Cetavelon (IEL Ltd., India) solution for 5 min, thoroughly washed with water, followed by surface sterilization with 0.1% solution of Mercuric chloride for 5-8 minutes. After 3 washings in sterile distilled water individual axillary buds were cultured on liquid MS medium supplemented with cytokinin (BA). The pH of the medium was adjusted to 5.8 prior to autoclaving at 121°C for 15 minutes. Sucrose 3% was used in MS medium in all the experiments.

Axillary shoot proliferation : The liquid MS and WPM (Woody Plant Medium) medium were tested for maximum shoot initiation from the cultured axillary buds. Both the media were variously supplemented with

cytokinins (BA and Kn) or auxins (NAA and IAA) singly and in combinations.

Shoot multiplication : The proliferated axillary shoots were excised and cut into 3-6 shoot clusters and cultured on agarified MS medium supplemented with different concentrations of BA and termed as first shoot multiplication. After first shoot multiplication the shoot cultures were cut into a group of 3 shoot cluster called as a propagule and regularly subcultured at 3-4 week intervals and maintained on agarified MS medium supplemented with cytokinin (BA). The number of propagules cultured and number of propagules derived at the end of subculture is regarded as the rate of multiplication. The shoot multiplication experiments have been regularly conducted and maintained over one year so far.

In-vitro rooting : Shoot clusters (2-6 shoots) were tested for *in-vitro* rooting. Agarified MS medium variously supplemented with IAA or NAA was used. Number of individual shoot clusters (Propagule) responding to rooting were counted and expressed as percentage rooting in Table 2.

Culture conditions : All cultures were maintained at 27±1°C under illumination for 14 hrs photoperiod with light intensity of 3000 lux obtained by white cool fluorescent tubes of 40 watts (Philips).

Transplantation : *In-vitro* rooted shoots (3-4 week) were transplanted to polybags containing a mixture of granular soil and soilrite (1:1 v/v) at the first transfer of *in-vitro* plantlets and later in soil and organic manure. The transplanted plants were hardened for 20-25 days in mist chamber under 80±5% RH and 30±2°C. The plants were supplied with half strength MS (devoid of organics) solution thrice a week. Later plants were shifted to an open shade house for acclimatization (5-6 months) before transfer to field condition. Plants which survived up to five months were counted for plant survival percentage.

Results

Axillary shoot proliferation : Axillary bud break was achieved in 70% of the cultures, on MS medium supplemented with 2.0-10.0 mg/l BA. The morphogenic differentiation of explants towards axillary but proliferation was markedly influenced by the concentration of growth regulator in the medium. At lower doses of BA (1.0-5.0 mg/l BA) in MS medium (liquid) distinct shoots proliferated (5-20 in number) in two to three weeks which on subculture multiplied rapidly (Fig. 1). Higher doses of BA (6.0-10.0 mg/l) in the MS medium induced thin, leaf like shoots, many of them did not develop further. Thus the optimal medium condition for axillary bud culture was (liquid) MS medium supplemented with 5.0 mg/l BA, where 10-20 shoots proliferated. No significant increase in shoot proliferation was obtained when auxins were added in MS medium along with BA. Shoot proliferation was not obtained on MS medium supplemented with only auxins. Axillary buds cultured on agarified MS medium showed exudation of phenolics at the basal cut end resulting in yellowing of shoots and poor growth axillary shoots.

Shoot multiplication : The proliferated shoots (2-3 weeks old) from the axillary buds were excised and cut into groups of shoot clusters and subcultured on liquid (paper bridge) as well as on agarified MS medium supplemented with 2.0-10.0 mg/l BA for shoot multiplication (Table 1). During first subculture an average shoot

multiplication rate of three fold was obtained in the liquid/agarified MS medium supplemented with 2.0-5.0 mg/l BA (Fig. 2). MS medium supplemented with 10.0 mg/l BA produced thin small shoots and thus were not found suitable for obtaining shoot propagules for subsequent cycles of shoot multiplication. Once the shoot cultures were established they were multiplied on MS + 3.00 mg/l BA medium by regular (four weeks interval) subcultures of shoot propagules. Repeated subculture in liquid medium resulted in vitrification of shoots. Hence agarified medium was used in subsequent subcultures. After 2 cycles of shoot multiplication a consistent 5 fold average multiplication rate was obtained (Fig. 3).

Table 1

Effect of different concentration of BA on shoot length and in-vitro shoot multiplication. A propagule of three shoots cultured on agarified MS medium (observation after 4 weeks)

BA Concentration (mg/l)	Mean Number of shoots produced	Mean shoot length (cm)
0.0	0.0	3.0
1.0	7.3	3.5
2.0	12.2	2.4
3.0	16.7	1.5
5.0	15.1	1.1
10.0	10.3	0.5

The *in-vitro* shoot cultures were established from 20 individuals plant sources. Shoot cultures of fourteen plant line were non-flowering and were similar in all respect. In these cultures an average shoot length of 1.5-2.5 cm was obtained on 3.0 mg/l BA medium. An increased shoot length was obtained (3.5 cm) when shoot propagules were subcultured on low BA (0.5-1.0 mg/l) medium. However in such cases decreased rate of average shoot multiplication (2 fold) was obtained. An average shoot length of 1.5-2.0 cm was found to be ideal for shoot multiplication.

Kinetin either alone or in combination with BA or NAA does not enhanced shoot multiplication rate. Auxins (IBA, NAA) when used with BA did not produced any significant results towards shoot multiplication. In WPM medium poor shoot multiplication with yellowing of leaves occurred.

In-vitro flowering : Nodal segments containing axillary buds were collected from 20 individual plant sources. Cultures of individual plant were marked as one separate plant line. *In-vitro* flowering was noticed in six of these plant lines (isolated and marked A-F). *In-vitro* flowering was not observed in any of the 20 plant lines so far. Some interesting phenomena were found associated with flowering and they are as follows.

Whenever shoot propagules of flowering line were transferred from 3.0 mg/l BA medium to rooting medium (MS + 3.0 mg/l NAA) flowering occurred in 2 weeks. The flowering was accompanied by rooting in the shoots (Fig. 5).

Rooting of in-vitro shoots : The *in-vitro* raised shoots failed to root on hormone free basal medium. Thus various auxins (IAA, NAA, IBA) were attempted for rooting trials. Rooting was obtained when shoot propagules were subcultured on agarified MS medium supplemented with 1.0-5.0 mg/l NAA (Table 2). Best rooting (80-85%) was obtained within 20 days of subculture on MS + 3.0 mg/l NAA (Fig. 6). Generally 5-8 roots emerged from the basal end of the

propagule. Single shoot on rooting medium did not survive, thus a propagule of minimum three shoots, were required for rooting. Size of the shoot propagule was also critical for rooting. Shoot length between 1.0 to 2.0 cm was found to be the best for rooting. Longer shoots (> 2.0 cm) showed a lower rooting percentage (60% on MS + 3.0 mg/l NAA).

Table 2

Effect of different concentration of NAA on in-vitro rooting and plant survival in field (after hardening and acclimatization) from a propagule of three shoots cultured on agarified MS medium.

NAA Concentration (mg/l)	Rooting Percentage (after 4 weeks) A	Plantlet survival (after 5 months) A (%)
0.0	0.00	0.00
0.5	15.32	70.14
1.0	30.33	88.26
2.0	58.66	94.32
3.0	85.32	96.42
4.0	81.28	95.36
5.0	75.14	94.66

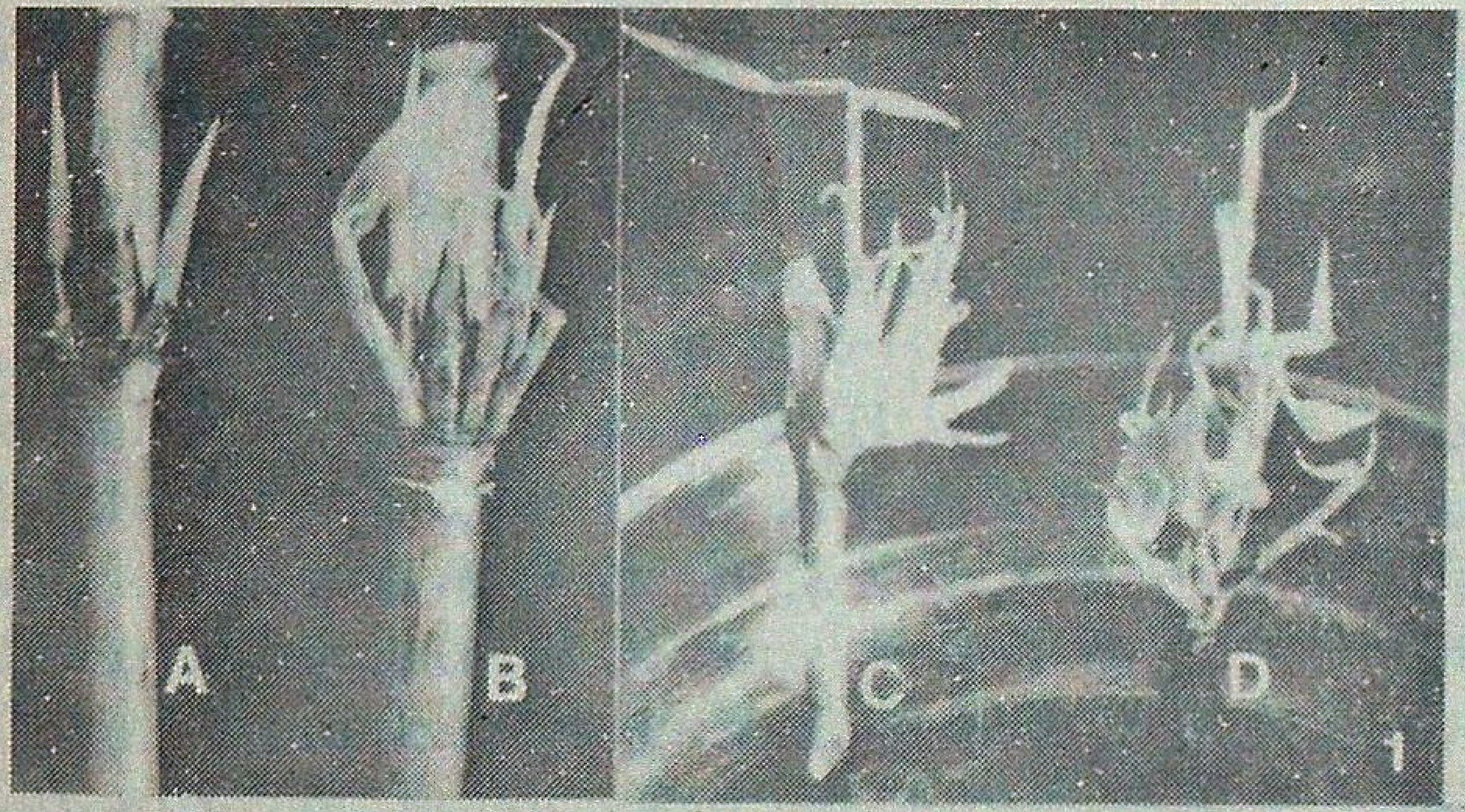
Transplantation : Four weeks old culture on rooting medium developed healthy root and shoot system. These plants were first transferred into soilrite : sand (2 : 1 v/v) mixture in polybags and kept in the mist chamber under 80% RH and 30+2°C for hardening. The plants were irrigated with half strength macro and micro-nutrients of MS medium thrice a week. After 20-25 days the hardened plants were transferred to bigger polybags containing soil, organic manure (1:1) and kept under shade house for acclimatization. After 6 months the plants were ready for field transfer (Fig. 7). During the last four months around 2000 plants have been produced. A continuous flow of plant from lab to land is in progress.

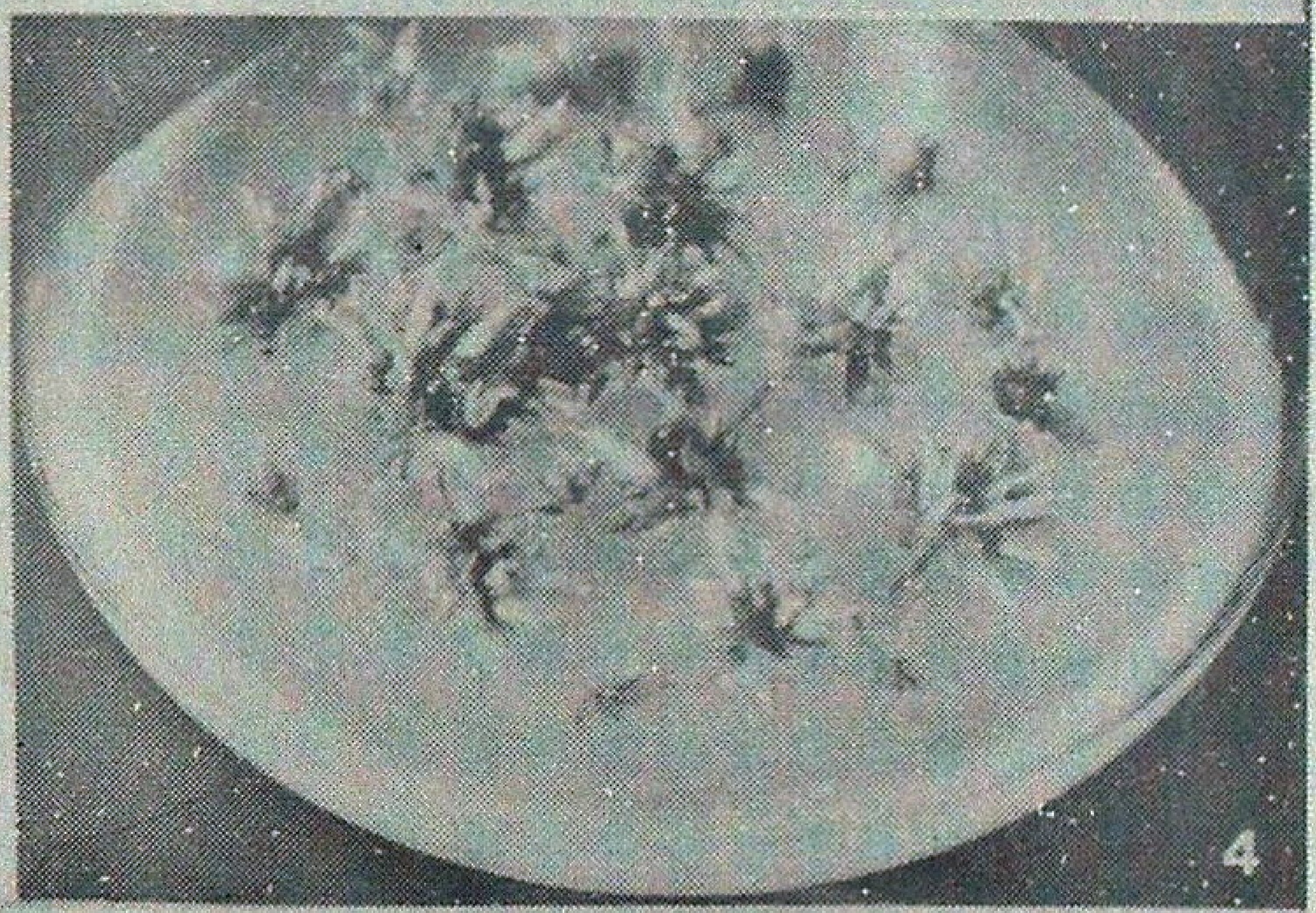
Discussion

Mostly bamboo is harvested from naturally occurring stands with minimal conservation or reforestation. Forest covers of *B. arundinacea* are fast declining because of poor harvesting methods and the lack of knowledge on propagation methods and flowering control (it dies after flowering). Thus it will be useful to develop an efficient *in-vitro* method for large scale propagation of this crop.

A very high rate (5 fold) of shoot multiplication was obtained with incorporation of BA in the culture medium which stimulated the growth of multiple shoots from the axillary buds and later during shoot multiplication. The present cultures are in 13th-18th subculture stage of shoot multiplication cycle and are maintaining the same potency for shoot multiplication. This method is thus useful for production of large indefinite number of plants (at commercial level) without repeated demand of fresh explant material. Further all the earlier reports on mircropropagation of bamboo involved a callus phase (except for Nadgir *et al.*, 1984 and Saxena, 1990) which can lead to genetically aberrant plants. The same is avoided in the present method described where multiplication of shoot occurred through axillary branching.

A very high rate (80-90%) of transplantation and plant survival was obtained in *B. arundinacea*. The success limits to the gradual procedure of hardening and acclimatization of the plants. Besides this transplantation rates of 70-80% have been reported only in *B. strictus* (Nadgir





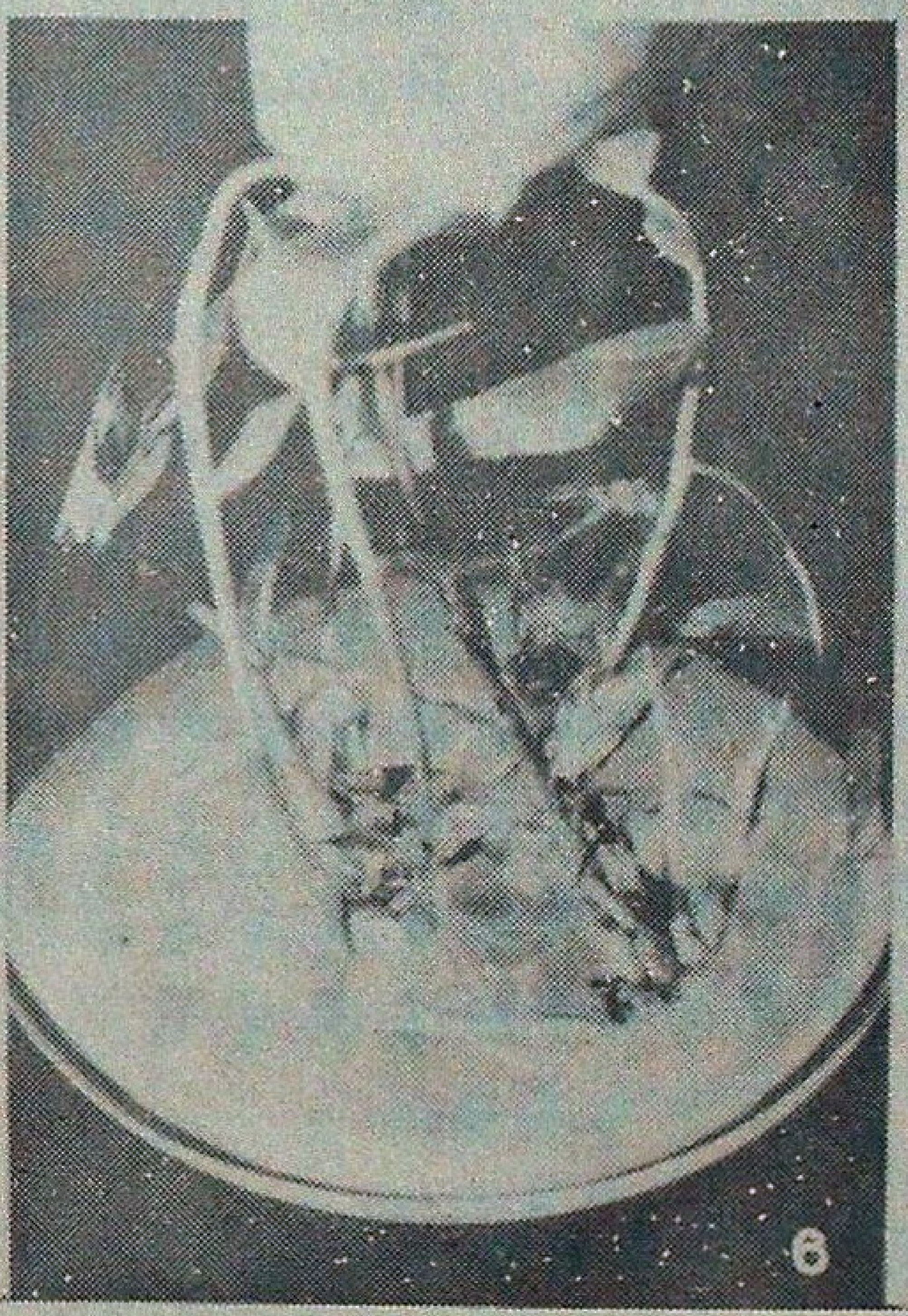


Fig 1. Axillary bud shoot proliferation on (A) MS + 1.0 mg/l BA. (B) MS + 3.0 mg/l BA. (C) MS + 5.0 mg/l BA. (D) MS + 10.0 mg/l BA.

Fig 2. Five fold shoot multiplication from three propagule on MS + 3.0 mg/l BA.

Fig. 3, 4. Comparative (Phenotypic) shoot multiplication. 3. Non-flowering and 4. Flowering line.

Fig. 5. *In-vitro* flowering, arrow indicates *in-vitro* anthers.

Fig. 6. *In-vitro* plantlet.

Fig 7. Polybags transfer after hardening and acclimatization.

et al., 1984) and in *B. tulda* (Saxena, 1990). Large number of plant transfer is however, not mentioned in published papers on micropropagation of bamboos.

The sporadic *in-vitro* flowering is also observed in few Bamboo species (Nadgauda, *et al.*, 1990, Prutpongse and Gavinlertvatana, 1992; Das and Rout, 1991; Chambers *et al.*, 1991). In most of these reports culture conditions did not have any effect on the flowering response, and it was random and at low frequency. However Nadgauda *et al.* (1990) were able to induce flowering in *B. arundinacea* and *Dendrocalamus brandsii* by the three subcultures on media containing 5% (v/v) coconut water and BA (2.2 µm) in MS medium. In present study incubation of flowering line (A to F) cultures on BA supplemented medium (during shoot multiplication) was necessary for flowering, however maximum flowering occurred when these shoots were transferred from BA medium to NAA (3.0 mg/l) supplemented medium in two weeks with root formation. Present results are similar to Chambers *et al.* (1991) who obtained flowering in *D. hamiltonii*. However the role of BA in floral induction remain unclear, and warranted further investigation. Flowering does not occur *in-vivo* until *B. arundinacea* plant has grown vegetatively for around 40 years. Thus controlled induction of flowering *in-vitro* may provide a useful model to study flowering patterns and to develop hybridization methods in this bamboo.

This is the first published report on micropropagation of *B. arundinacea* from nodal segments in which a large number of plants have been successfully transferred to field. A high rate of shoot multiplication averaged 5 fold with 80 per cent rooting and high plant survival rate are attractive feature of this study.

SUMMARY

Bamboos are versatile multipurpose forest produce which play a vital role in our domestic economy. *Bambusa bambos* is the principle source for paper and pulp besides being used for constructional purposes and provides food materials. The conventional methods of its propagation have a lot of problems which restrict its multiplication on a large scale. A tissue culture technology is developed for large scale multiplication of *Bambusa bambos* which is discussed.

प्ररोह बहुलन द्वारा *बैम्बूसा बैम्बस* की अणु प्रवर्धन प्रौद्योगिकी

सरिता आर्य व सुषमा शर्मा

सारांश

बांस बहुमुखी बहुप्रयोजन वनोपज है जिसकी हमारे देश की अर्थ-व्यवस्था में महत्वपूर्ण भूमिका है । *बैम्बूसा बैम्बस* अनेक निर्माण कार्यों के लिए उपयोग किया जाने और खाद्य पदार्थ उपलब्ध कराने के अतिरिक्त कागज और लुगदी उद्योग के लिए मुख्य स्रोत है । इसकी पारम्परिक प्रवर्धन विधि में कितनी ही समस्याएँ हैं जो बडे परिमाण पर इसका प्रवर्धन कराने में बाधा डालती है । *बैम्बूसा बैम्बस* के बृहत परिमाण पर बहुलन कराने के लिए एक ऊति (टिश्यू) संवर्धन प्रौद्योगिकी का विकास किया गया है जिसका विवेचन इस अभिपत्र में दिया है ।

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GROWTH, SURVIVAL AND MEAN ANNUAL INCREMENT OF *QUERCUS LEUCOTRICHOPHORA* (BAN OAK) ON DEGRADED LANDS OF DOON VALLEY

CHARAN SINGH, M.K. VISHWANATHAM, NIRMAL KUMAR AND M.C. AGARWAL

Central Soil and Water Conservation Research and Training Institute, Dehra Dun (India)

Introduction

Oak (*Quercus*) occupy a sizeable areas in the Himalayas. The Oak forest grows in the State of H.P., J&K and U.P. in the North West Himalayan region. Oaks are widely used locally by the natives for their daily requirement of fuelwood, small timber, wood for house building and agricultural implements, charcoal and fodder. Hence Oak forest have an important place in the rural economy of the region. The value of these forests both economic and protective in the North-West Himalayan region has now been realized (Gupta 1993, Singh, 1973 and Singh, 1983).

Quercus leucotrichophora (Ban Oak) is one of the main species of Oak, which grow gregariously and extensively in the outer and middle ranges of North-West Himalayas between the altitude of 1000-2500 m above the m.s.l. It can grow in lesser altitude where soil moisture conditions are favourable.

The present study has been aimed to study the possibility of growing *Quercus leucotrichophora* on the degraded lands of Doon Valley through growth, survival and Mean Annual Increment (MAI) so that this species can be grown on large scale where soil and water conservation measures are to be carried out on priority basis.

Materials and Methods

The study was conducted at the Research Farm, Selakui of the Central Soil and Water Conservation Research and Training Institute, Dehra Dun (30° 21'N latitude, 70° 52'E longitude and at an altitude of 517 m above m.s.l.), which is about 16 km North-West of Dehra Dun.

The genesis of the soil is of very deep recent alluvium on riverbed. Layers with various thickness having different percentage of coarse fragment (boulders and gravel 20 to 80 per cent) are visible throughout the profile depth. The texture of the soil varies from loamy sand to sandy loam (Satyanarayana and Dhir, 1959). The average annual rainfall is 1672 mm. The maximum temperature goes upto 45° during summers while the minimum has been recorded as low as 0 °C during the winter months.

Quercus leucotrichophora seedlings of uniform age and size were transplanted at a spacing of 4m x 4m in a compact block of 20 trees x 20 trees during Aug., 1986. The survival, height and collar diameter were

recorded once in a year during December from 1986 to 1994 while D.B.H. were recorded from 1988 to 1994. The border plants were not included in the collection of observation on survival, height, collar diameter and D.B.H. The damaged plants (top broken or top dried plant) were included in the survival but these plant's were not taken into consideration henceforth for height, collar diameter and D.B.H. observations.

The following linear and 2nd degree polynomials were fitted to predict the height, collar dia. and D.B.H. of Ban Oak plantation from plant age.

$$Y = b_0 + b_1X$$
$$Y = b_0 + b_1 X + b_2x^2$$

where Y = Any one of the prediction variable from height, collar dia. and D.B.H. (cm) 'b_0' is constant and b_1 is the regression coefficients.

These equations were fitted against plant age (X) for the height/collar dia./DBH (i) considering the data of all the survived plants (excluding the border and damaged plants) and (ii) considering annual mean height/collar dia/DBH (cm).

Results and Discussion

Number and percentage of plant survival based on different initial height and collar dia Classes of plantation (excluding the border plants) are presented in Table (1a and b). It was observed that the survival of plants were less with the initial height of less than 10 cm and initial collar dia upto 0.3 cm. Hence, it may be inferred that at the time of transplanting of plants, they should have more initial height and collar dia for better survival percentage.

Growth statistics of plants (excluding border and damaged plants) for annual mean height, collar dia (CD) and diameter at breast height (DBH) for different years are presented in Table 2 and Fig. 1. The annual mean height, collar dia and D.B.H. of plants are showing increasing trend as the plants grows. However, the rate of change in these growth characters decreases as the plants grows. It was further inferred that the standard deviation increases for these three growth characters as the plant grows in different years except for last year. The coefficient of variation (CV) follows the decreasing trend for these three parameters a the plants grows. On the basis of these three growth parameters (i.e. height, collar diameter D.B.H.) from 1986 to 1994, it is quite evidence to grow Ban Oak on degraded lands. Moreover, growth of it in degraded lands are quite comparable with other good lands (Gupta, 1993).

It was observed that the mean annual increment (MAI) of its plants in respect of height increase sharply upto 1988 and thereafter it varies within a range of 40-50 cm. The M.A.I. of collar diameter increases sharply upto the year 1989 and thereafter it varies within a very narrow range and appears to be increase at the same rate. The M.A.I. of D.B.H. increases throughout except for the last year (i.e. 1994) where it's value was lower than the previous year's value (i.e. 1993) (Fig. 2).

Various linear and second degree polynomials were fitted to describe the relationship between individual character i.e. height, collar dia and D.B.H. (cm.) against the age of plants as independent variable considering (i) individual plants and (ii) annual averages. Coefficient of determination (R^2) and standard error of

Table 1a

Q. leucotrichophora plant survival in different years based on initial height

Year	Initial height (cm)				Total Survival	Survival per cent
	Upto 10	>10-15	>15-20	>20		
1986	75	124	84	41	324	100.0
1987	63	117	81	40	301	92.9
1988	56	104	70	35	265	81.8
1989	51	100	67	33	251	77.5
1990	45	99	67	33	244	75.3
1991	42	96	67	33	238	73.5
1992	42	91	67	32	232	71.6
1993	36	87	62	29	214	66.0
1994	29	73	53	26	181	55.9

Table 1b

Q. leucotrichophora plant survival in different years based on initial collar diameter

Year	Initial collar dia (cm)				Total
	Upto 0.2	0.3	0.4	>0.5	
1986	84	119	88	33	324
1987	76	114	82	29	301
1988	70	98	72	25	265
1989	66	91	69	25	251
1990	62	89	68	25	244
1991	59	88	66	25	238
1992	57	86	66	23	232
1993	53	76	64	21	214
1994	45	58	58	20	181

the respective regression coefficient were also worked out (Table 3).

It is observed that regression coefficients were statistically significant for linear relationship at 99 per cent confidence level for all the individual characters (i.e. height, collar dia and D.B.H.) in both cases under study i.e. considering (i) individual plants data and (ii) annual averages. Polynomial of second degree with height for all individual plants, both regression coefficient were significant at 99 per cent confidence level. First regression coefficient was found significant for the polynomial with collar dia and second regression coefficient with the D.B.H. at 99 per cent confidence level for all individual plants. To fit the polynomials of second degree from annual average of height, collar dia and D.B.H. of first regression coefficient were found significant at 99 per cent confidence

Table 2

Growth statistics of Q. leucotrichophora plantation (excluding border and damaged plants)

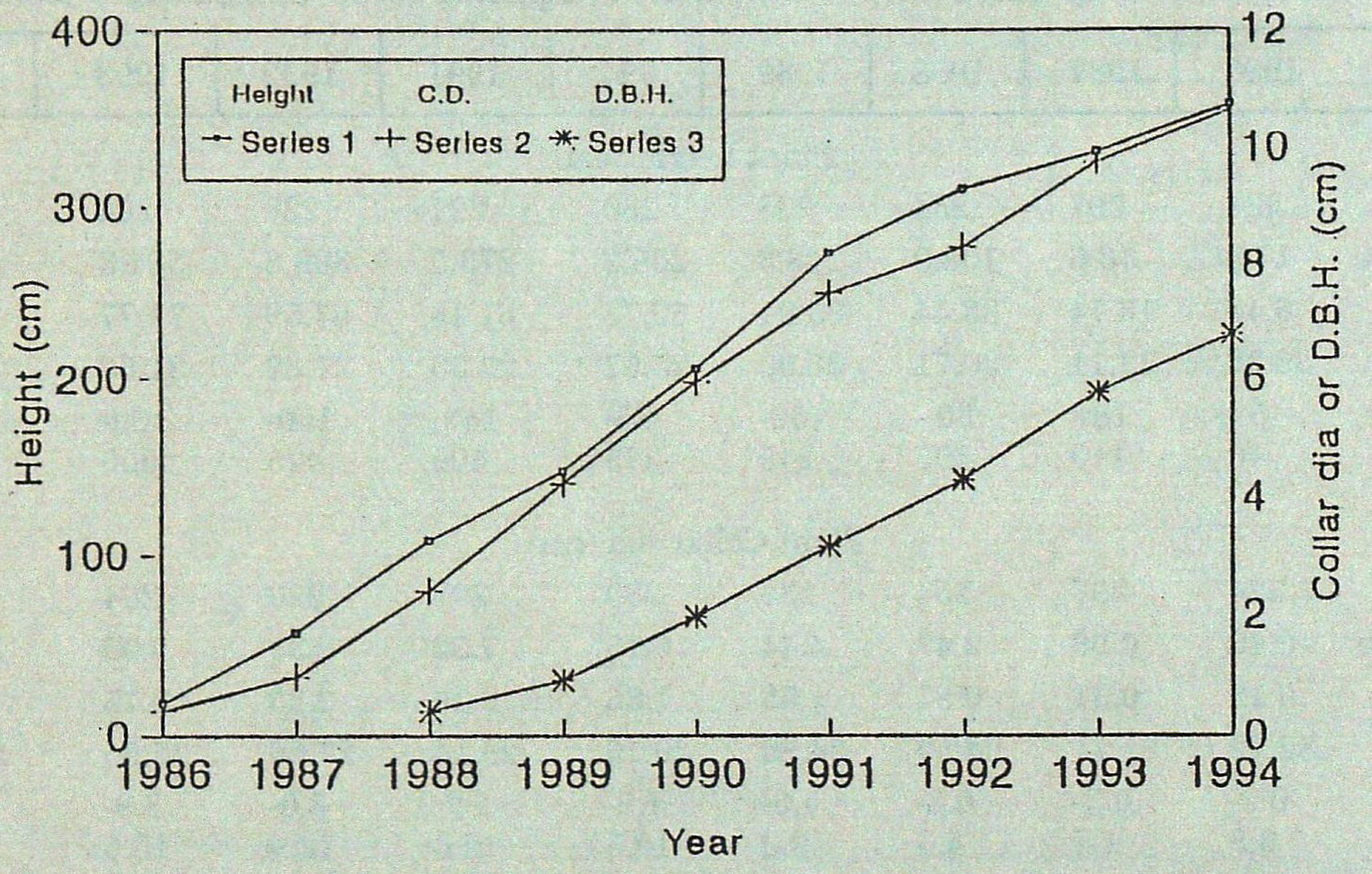
	1986	1987	1988	1989	1990	1991	1992	1993	1994
				Plant height (cm)					
Count	324	297	254	233	230	227	220	204	167
Average	17.8	56.6	108.9	148.3	206.2	273.5	309.8	331.3	358.1
S.D.	6.48	18.74	33.44	39.91	52.73	61.15	67.59	71.77	71.08
C.V.	36.32	33.11	30.71	26.90	25.57	22.36	21.82	21.66	19.85
Range	5 - 40	18 - 110	30 - 195	50- 245	85- 375	150- 400	150- 475	160- 500	180- 550
				Plant Collar dia (cm)					
Count	324	297	254	233	230	227	220	204	167
Average	0.40	0.98	2.47	4.44	6.15	7.52	8.33	9.99	11.14
S.D.	0.13	0.31	0.85	1.55	1.86	2.19	2.25	2.75	2.72
C.V.	32.72	31.71	34.50	34.80	30.16	29.14	27.06	27.55	24.47
Range	0.2- 0.8	0.3- 1.7	0.3- 4.3	1.3- 9.3	1.8- 10.5	2.9- 12.0	3.0- 12.9	3.9- 16.5	4.6- 18.0
				Plant D.B.H. (cm)					
Count			54	148	216	227	220	204	167
Average			0.41	0.91	1.97	3.17	4.30	5.87	6.89
S.D.			0.17	0.54	1.08	1.55	1.86	2.17	2.29
C.V.			42.65	58.66	54.78	48.92	43.26	37.02	33.25
Range			0.2- 1.3	0.2- 2.2	0.3- 4.8	0.3- 7.6	0.5- 10.7	1.4- 11.5	1.6- 12.4

level for height as well as for collar dia while none of the regression coefficient were found significant for D.B.H.

R-squared statistic of linear and quadratic regression relationship for all the three character viz. height, collar dia and D.B.H. were almost same in both the relationship which explained 58.4 and 76.9 per cent variability for height, 84.8 and 85.0 per cent for collar dia and 80.7 and 80.7 in DBH when individual plant data were used. However, about 99 per cent (ranged from 98.5 to 99.6) variability were observed for all the three characters in both the models when annual averages were used.

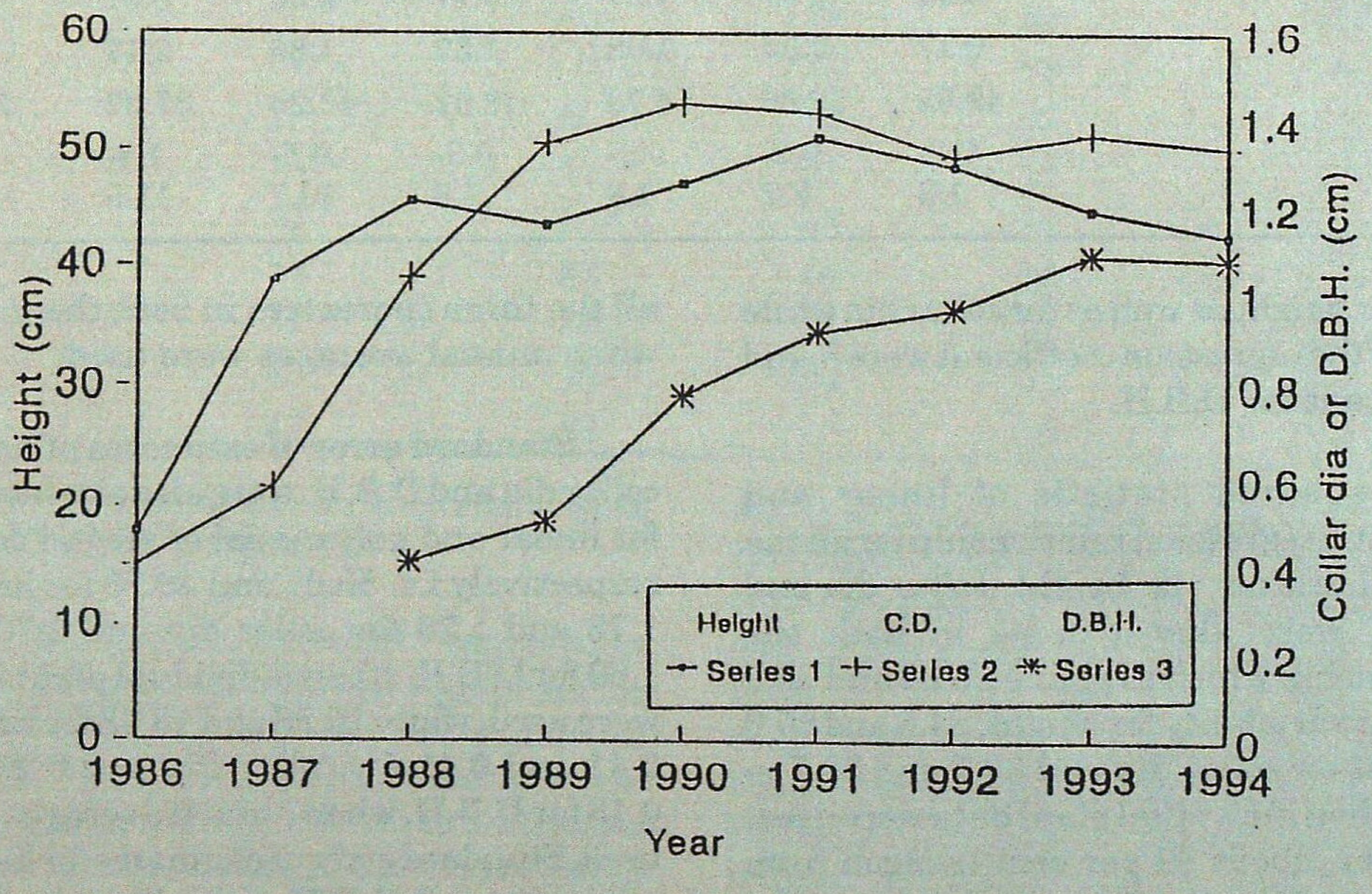
Standard error of estimates of height, collar dia and D.B.H. were also almost same for linear and polynomial of second degree respectively i.e. 50.07 and 49.75 for height, 1.78 and 1.78 for collar dia and 1.70 and 1.69 for D.B.H. when individual plants data were used, while 16.28 and 13.38 for height, 0.41 and 0.41 for collar dia and 0.28 and 0.18 for D.B.H. when annual averages were used. Standard error of estimates for height, collar dia and D.B.H. were less in case of

Fig. 1



Annual average growth

Fig. 2



Mean Annual Increment (MAI)

Table 3

Regression constant, standard error and R-squared statistics (Excluding border and damaged plants)

Variable under study	Linear regression equation			Standard error of estiamtes	Second degree Polynomial				Standard error of estimates
	a	b	r^2		b_0	b_1	b_2	R^2	
				Individual Plants					
Height	-0.0595	45.3004** (0.413)	0.848**	50.07	-11.0220	53.8456** (1.645)	-1.0178** (0.190)	0.850**	49.75
Collar dia	-0.5015	1.3959** (0.015)	0.807**	1.78	-0.5195	1.4099** (0.059)	-0.0017 (0.007)	0.807**	1.78
D.B.H.	-3.1122	1.1672** (0.028)	0.584**	1.70	-0.8592	0.2862 (0.187)	0.0779** (0.016)	0.769**	1.69
				Annual average of plants					
Height	2.1707	45.2058** (2.094)	0.985**	16.28	-16.9055	58.4309** (7.154)	-1.5029 (0.787)	0.991**	13.38
Collar dia	-0.4694	1.3726** (0.052)	0.990**	0.41	-0.7370	1.5582** (0.212)	-0.0211 (0.023)	0.991**	0.41
D.B.H.	-2.6817	1.1122** (0.052)	0.989**	0.28	-1.3100	0.5233 (0.218)	0.0545 (0.020)	0.996**	0.18

annual averages compare to individual plants.

On the basic of regression coefficients, R^2 -statistics and standard error of estimates, it was concluded that linear regression equations from annual averages were quite suitable to predict the height, collar dia or D.B.H. from the age of plants.

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SUMMARY

***Quercus leucotrichophora* (Ban Oak), is a most suitable tree species for protective and productive purpose in the degraded lands of higher altitude of North-West Himalayan region. An attempt has been made to explore the possibility of its growing in the lower altitude i.e. in the degraded lands of Doon Valley so that its large scale plantation can be taken up where soil and water conservation measures are to be carried out on priority basis. On the basis of survival, height, collar diameter and diameter at breast height performance from 1986 to 1994, it is possible to grow it on degraded lands of Doon Valley. Moreover, its growth performance in degraded lands are quite encouraging. The regression equations between plant age with individual growth character (i.e. height or collar diameter or diameter at breast height) were also estimated.**

दूनघाटी की व्याह्सित भूमियों पर बान बंजु (*क्वेरकस ल्यूकोट्राइकोफोरा*) की बढ़वार, अतिजीविता और माध्य वार्षिक संवृद्धि

चरण सिंह, एम०के० विश्वनाथम, निर्मल कुमार व एम०सी० अग्रवाल

सारांश

क्वेरकस ल्यूकोट्राइकोफोरा (बान बंजु) उत्तर पश्चिमी हिमालय प्रदेश की अधिक ऊंचाईयों वाली भूमि की सुरक्षा और उत्पादकता प्रयोजनों के लिए लगाने की सर्वाधिक उपयुक्त वृक्ष जाति है । यहाँ यह संभावना खोजने का प्रयास किया गया है कि इसे कम ऊंचाईयों वाले क्षेत्रों अर्थात् दूनघाटी की व्याह्सित भूमियों में उगाया जा सकता है या नहीं ताकि बडे परिमाण पर इसके रोपवन लगाने का काम शुरु किया जा सके जहाँ पूर्वता के आधार पर मृदा और जल संरक्षण कार्यों को कराया जाना है । 1986 से 1994 तक इसकी अतिजीविता, ऊंचाई, मूल संधि पर व्यास और वक्षोच्चता पर व्यास सक्रियता के आधार पर देखा जाए तो *क्वेरकस ल्यूकाट्राइकोफोरा* को दूनघाटी की व्याह्सित भूमियों पर उगाया जा सकता है । इसके अतिरिक्त व्याह्सित भूमियों पर इसकी बढ़वार सक्रियता काफी उत्साहजनक है । पृथक-पृथक वृद्धि लक्षणों अर्थात् ऊंचाई या मूल संधि पर व्यास अथवा वक्षोच्चता पर व्यास के साथ पादप की उम्र के प्रतीपायन समीकरण भी आकलित किए गए हैं ।

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IMPROVEMENT OF PLANTING STOCK THROUGH CULLING IN ROOT TRAINER NURSERY

G. MAHESWARA RAO*, A. RAMA RAO**, M.V.S.N. ACHARYULU** AND N.SYAM PRASAD***

Regional Forest Research Centre, Rajahmundry (Andhra Pradesh)

Introduction

It is obligatory to introduce root trainer nursery technology for production of quality planting stock, and thereby increase productivity of plantations. A good seed source and a good potting medium are pre-requisites for raising good nursery stock. Another important pre-requisite for successful plantations is ensuring the uniformity in planting stock. The homogeneity of plantations raised from the wild forest tree sources can be improved by rigorous culling. This involves major culling of germinants before transplanting into root trainers and a low level culling before plants are ready for planting.

Ten economically important forest tree species have been identified to study the level of culling in root trainer plants before the plants are ready for transportation to the planting site.

Culling

Systematic removal of individuals not desired for the perpetuation of a population.

Materials and Method

The experiment of culling in root trainers was carried out on following ten forest tree species :

Adina cordifolia
Anogeissus latifolia
Emblica officinalis
Lagerstroemia parviflora
Mitragyna parvifolia
Pterocarpus marsupium
Sterculia urens
Terminalia arjuna
Terminalia chebula
Terminalia tomentosa

Seed Collection : The seed was collected from seed stands of wild sources from Eastern Ghats in East Godavari and West Godavari Districts. The seed/fruit was collected from mature fruits. Seeds were dried and mixed with BHC 10%, and stored in gunny bags. *Sterculia urens* seed was collected from trees vegetatively propagated and planted in Regional Forest Research Centre, Rajahmundry

Seed Pre-sowing Treatments : As observed in the experiment "Standardisation of Nursery Techniques for Some Forest Species" at Regional Forest Research Centre, Rajahmundry, effective pre-seed treatments are given to get good germination percentages (Table 1).

Transplanting : Good looking peak germinants of each seed lot were transplanted into root trainers of 160 ml

* Research Assistant, ** Range Officers, ***State Silviculturist

Table 1

Species	Pretreatment	Germination (%)	Peak germination (%)
Adina cordifolia	Overnight soaking in cold water	2.7	1.8
Anogeissus latifolia	Soaking in cold water for 48 hrs.	18.0	13.0
Emblica officinalis	Overnight soaking in mild hot water	78.0	43.0
Lagerstroemia parviflora	Overnight soaking in cold water	20.0	17.0
Mitragyna parvifolia	Overnight soaking in cold water	2.7	1.5
Pterocarpus marsupium	Alternate wetting and drying for 7 days	42.0	30.0
Sterculia urens	Overnight soaking in cold water	43.0	23.0
Terminalia arjuna	Alternate wetting and drying for 15 days	72.5	50.0
Terminalia chebula	Alternate wetting and drying for 7 days	57.5	20.0
Terminalia tomentosa	Alternate wetting and drying for 9 days	57.5	24.5

filled with soil mixture of Farm Yard Manure, Red Earth and Sand in the proportion of 1:1:½. Two kg of single superphosphate and ½ kg of BHC 10% is mixed to 1 m^3 of soil mixture. Twenty four root trainers are arranged in a steel frame tray of 23 cm x 35 cm and the trays are placed on stands 0.7 m above the ground level.

Irrigation : Overhead perfo-irrigation is provided thrice daily. As plants grow larger in a period of 8-10 weeks, the overhead system has not been fully effective because of the "Umbrella effect" of the leaf area on some species. Then plants are watered manually with rose cans to over come umbrella effect.

Laying of Sample Plot to observe Seedling Development : Root trainer plants in trays of each species are kept in rows on stands. Two sample plots of half square metre, each are laid at random for each species transplanted same period from one seed lot. Thus two sample plots have 12 trays holding 24 root trainers in each tray.

Growth Data : Heights of individual seedlings in two sample plots are recorded and data is pooled. From the pooled data

Table 2

Species	Total plants planted	No. of observa- -tions	Range of. C.I.	Assum- ed mean	S.D.	C.V.	Remarks
Adina cordifolia	7000	288	3-11	7.0	1.8	26.0	Higher than 15%
Anogeissus latifolia	3800	277	9-34	21.5	5.34	24.86	Higher than 15%
Emblica officinalis	13600	276	6-36	21.0	5.50	26.20	Higher than 15%
Lagerstroemia parviflora	5800	265	2-17	9.5	3.28	34.0	Higher than 15%
Mitragyna parvifolia	2400	281	10-30	20.0	4.05	20.25	Higher than 15%
Pterocarpus marsupium	5800	287	6-41	23.5	6.95	29.5	Higher than 15%
Sterculia urens	1000	273	4-14	9.0	1.09	12.0	Less than 15%
Terminalia arjuna	1400	272	12-30	21.0	4.10	19.5	Higher than 15%
Terminalia chebula	11600	272	9-34	21.5	6.30	29.31	Higher than 15%
Terminalia tomentosa	20000	261	7-42	24.5	5.73	23.38	Higher than 15%

mean height, standard deviations and co-efficient of variations are calculated. (Table 2).

The size class distribution diagram is plotted using "Harvard Graphics Software".

(a) *Standard Deviation (S.D.)* : Standard deviation is the square root of the arithmetic average of squares of deviations measured from mean.

$$\text{S.D.} = \frac{\sqrt{\Sigma f dx^2}}{n} - \left[\frac{\Sigma f dx}{n}\right]^2$$

Where f = Frequency
dx = Deviation
dx^2 = Squares of deviation
N = No. of observations.

(b) *Mean* : Mean is equal to sum of total observations divided by number of observations.

$$\bar{x} = \frac{\Sigma f x}{\Sigma f}$$

(c) *Co-efficient of Variations (C.V.)* : Co-efficient of variation is the expression of the calculated Standard Deviation (S.D.) as a percentage of calculated mean.

$$\text{C.V.} = \frac{\sigma}{\bar{x}} \times 100$$

Where
σ = Standard deviation
$\bar{x}$ = Calculated mean

Seedling culling : From the Coefficient of variation table it is clear that all species except *Sterculia urens* need further culling to minimize variation in planting population. To determine the level of culling at root trainer stage to meet the coefficient variation (less than 15%) target, the size class distribution diagram is drawn.

Median of the sample population is statistically calculated and projected on size class distribution graph.

Median is expressed as :

Table 3

Species	Before culling		Median	After culling		Culling (%)
	Class	Co-efficient of variation		Class	Co-efficient of variation	
Adina cordifolia	3-11	26.00	7.12	5-9	15.65	32.00
Anogeissus latifolia	9-34	24.86	22.30	17-27	12.50	31.00
Emblica officinalis	6-36	26.20	21.18	15-27	15.09	24.00
Lagerstroemia parviflora	2-17	34.00	9.29	6-12	15.77	22.00
Mitragyna parvifolia	10-30	20.25	19.72	15-25	13.00	18.00
Pterocarpus marsupium	6-41	29.50	20.14	15.25	14.00	44.00
Sterculia urens	4-14	12.00	8.38	—	—	—
Terminalia arjuna	12-30	19.50	21.18	16.26	12.57	23.00
Terminalia chebula	9-14	29.31	20.50	15.25	14.71	51.00
Terminalia tomentosa	7-42	23.38	24.94	18.32	15.36	25.00

$$L + \left[\frac{\frac{n+1}{2} - m}{f} \right] \times c$$

Where L = Lower limit of the mean class
n = No. of observations
m = Cumilative frequency just proceeding to mean class
f = Maximum frequency
C = Width of the C.I.

Then class intervals (C.I.) are chosen on either side of the median value to know which class intervals should go to the planting site leaving the balance class intervals of both extreme sides of the graph so as to manipulate the C.V. value to permissible percentage level i.e. around 15.

Results

Recorded observations are put to a statistical analysis to see whether secondary culling in root trainer stage is required to minimize the variations. Thereafter the percentage of culling required for the ten selected forestry species under the experiment at root trainer stage is calculated. (Table 3).

Summary

Seedlings raised from the seed collected from wild source require about 20% to 30% culling in secondary stage (Root trainer plants) to have uniformly good planting stock.

जड़ नियंत्रक (रूट ट्रेनर) पौधशाला में छंटाई द्वारा रोपणी सामग्री का सुधार

जी० महेश्वर राव, ए० रामा राव, एम०वी०एस०एन० आचार्युलू व एन० श्याम प्रसाद

सारांश

वन्य स्रोतों से एकत्रित बाजों से उगाए गए पौधों को द्वितीयक अवस्था (रूट ट्रेनर प्लान्ट्स) में, एक समान अच्छी रोपण सामग्री प्राप्त करने के लिए कीव 20% से 30% छंटाई की आवश्यकता होती है ।

RESEARCH NOTES

(I)

DISOXYLOM PROCERUM - A POTENTIAL SOCIAL FORESTRY PLANT

Introduction

Disoxylom procerum, grows fast in the large areas of the central alluvial zones in West Bengal. It has been planted by private growers. Since it is not being planted in forest areas, the authors tried to explore the feasibility of adopting this spp. in our Social Forestry plantations. Recourse, therefore, had to be taken to collection of data from the private plots (homestead) in North 24-Parganas and Nadia Districts of West Bengal for analysis and projection on the same. This is therefore a preliminary report.

General description

At initial growth stage linear height expansion is more and simultaneous lateral expansion i.e. diameter increment is not so much. Thus upto 10-15 years plant attains 20-30 m height having clear straight bole i.e. without any branching and average crop and crown diameter are also lesser comparatively not exceeding 0.3 m and 3 m, respectively. In later stages lateral expansion is more. Thus after 15 years onwards crop diamter as well as crown diameter gradually increases and lateral branching also initiates from the top portion of the plant.

It has been observed from roadside that the plant can attain more than 50 m height, 4.35 m G.B.H. and 15-20 m crown diameter.

Morphology

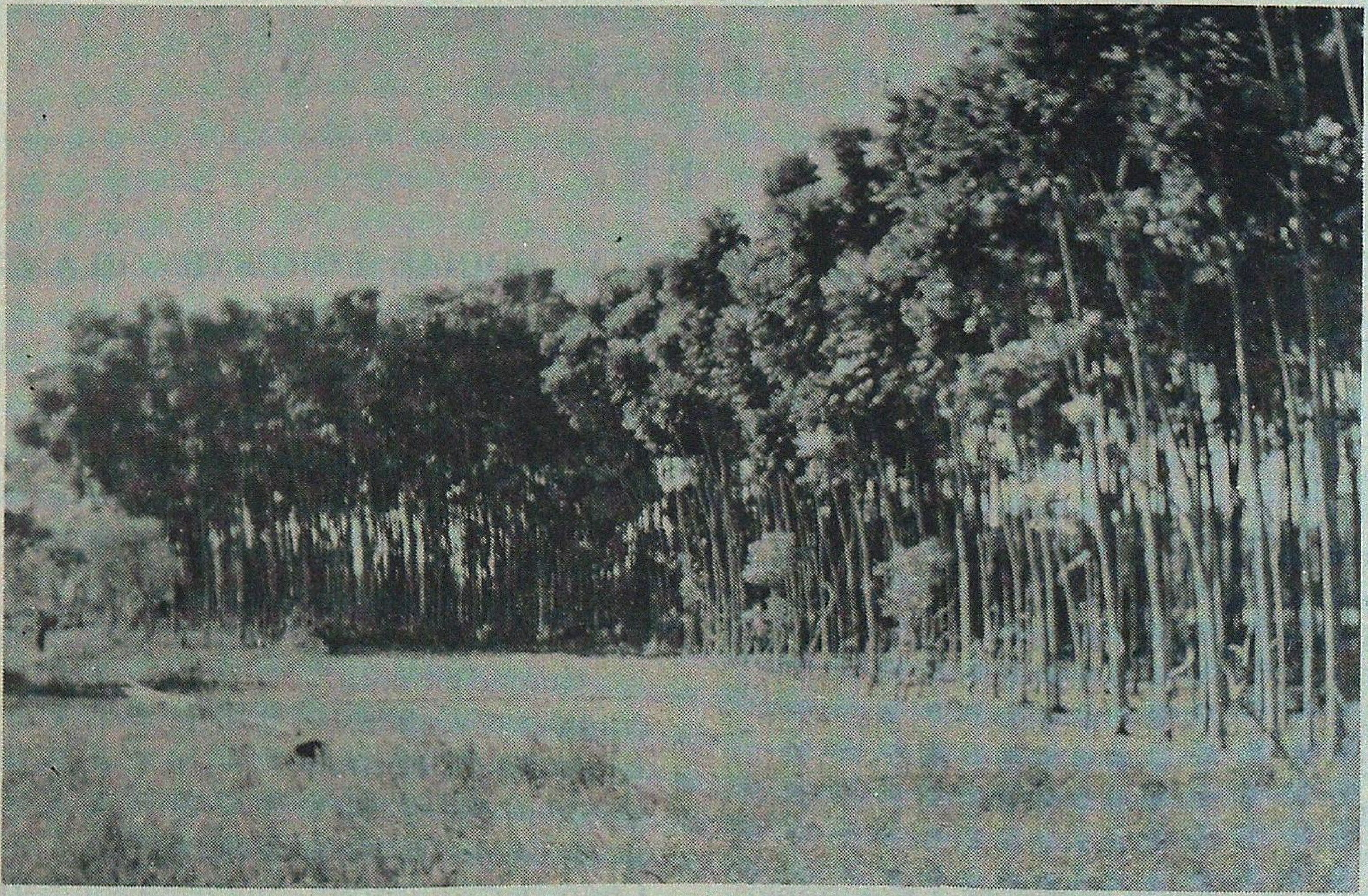
Tree - Perennial.
Stem - Strong, decurrent.
Leaves - Dark green unipinnately compound imparipinnate.
Number of Leaflets - 7-13.
Phylotaxy - Alternate.
Leaf margin - Entire.
Leaf shape - Obovate to elliptic.
Characteristic feature - Slightly asymmetric.
Inflorescence - Panicle.
Flower - Not observed.
Fruit - Drupe type (Sabeda type).
Fruit shape - Globose to pynform, 2.5-4 x 2-3.5, loculous 3 to 5 chambered.
Seed - Ariillous, embryo with oily cotyledon.

Phenology

Phenology of the tree in Nadia and 24-Parganas (North) could be ascertained by interviewing a large section of people.

Flowering time - February to first fortnight of March.
Fruiting time - Last fortnight of March to May.
Seeding time - June to July
Number of seed per fruit - 35 - 50
Average fruit production per plant (15 to 20 years plant) - 2500-3000.
Germination percentage - 95

Fig. 1



7 year old *D. procerum* plantation

Silvicultural characteristics

Evergreen tree, prefers alluvial tracts and medium to high rainfall area, medium textured soil. Light demanding species, medium to good coppicer.

Suitability to Agroforestry

As the average crown diameter of the plant is comparatively less, it is very much suitable species for Agroforestry particularly in West Bengal where land fragmentation is too high. It is common scenario in 24 Parganas (North) and Nadia that the plantation is done along the borderline of the plot in combination with alternate agricultural crop within that plot.

Homestead plantation along the boundary is also prevalent in these districts.

Disease

Gummosis : Gum exudes from venous points of the affected stem and pimple like appearance over the stem are very common. Symptom observed in 7 to 8 years crowded plantation.

Insect

Mealy bug : Plant suffers considerably as the insect constantly suck the plant sap. The insect attacks the tender portion of stem, shoot and petiolar portion of leaves. Attacked portion appears as whitish woolly

or cottony mass. Affected plant shows stunted growth, reduced number of leaves etc. It has been observed in young plants as well as 7 to 8 years old crops.

Malformation

Affected plants show characteristics symptoms on the tender apical shoot. Symptoms are characterised by reduced leaf size, shortening of internode, somewhat yellowish greening of leaves and ultimate bushy appearance of the affected plants. It has been observed in 7-8 year old crops.

Use

Wood is fit for door and window frame, good in furniture making also.

Price

Approximate present market value of wood in round timber (1997-98) as ascertained through interview:

Diameter class (m)	Rs. per m^3
2-4	4572
4-6	6096-7620
6-8	9144

Price of seedling

Rs. 2/- per seedling (10-15 cm seedling).
Rs. 10/- per seedling (0.90 - 1.2 m seedling).

Nursery practice

Nursery bed preparation : Normal bed size will be 6 m x 1.2 m. Bed soil should be well pulverized and mixed with adequate amount of cowdung manure. To prevent termite and red ant any sort of soil insecticide like B.H.C., Gamaexene etc. can be applied at suitable dose.

Seed treatment : Seed soaking in water (preferably in pond water), found good result followed by decanting of excess water and then water soaked seeds are placed in gunny bag and kept in shade. Sprinkle water once in a day over seed filled gunny bag. Within 3-4 days seed germinates. Good germinated seed is to be planted in the mother bed and bad non-germinated seed is to be discarded. Seed sowing in the mother bed should be done in such a way that the emerged radicle only kept inside the soil. Seedling should be pricked out from the mother bed at 3-4 leaves stage and transferred to polypot and afterward necessary sorting, shifting, culling, weeding, watering, etc. are done as and when required. Transplantation can be done in case of 2 month old seedling attaining a height of 15 cm, but one year old seedling is more preferable for transplantation.

Spacement

Plantation can be done at a spacement of 1.5 m x 1.5 m initially but after 5-6 years thinning will be required.

Social Forestry

Kalapur Gram Panchayet No. 2 as a venture in Social Forestry, raised plantation over 7 ha approx. in scattered patches.

System of management and contract

1. Took 25 years Lease on private land.

2. Panchayat will bear all cost for creation and maintenance for that plantation.

3. After termination of the project crop will be shared half to land owner and other half to Panchayat.

Utilisation

Its wood is medium density 0.629 gm/cm^3, stable and resembles to *Cedrela toona* in respect of wood grain, color, porosity, and many other attributes. The wood is porous but rarely splits during natural seasoning. It is used for making furniture, door, window panel, packing materials, wooden object making like spoon, toy etc. Fuelwood or plywood value are not so remarkable.

Coppicing vigour

Generally coppiced well. Plant attain 1 m to 1.75 m height within 12 months (which is observed in private plot where coppice plants are maintained under selection felling system (i.e. shaded condition). There, coppice has been done during July-August. Initially multiple shoots arise and finally one or two leading shoot are kept. Here grazing is the main constraint for coppice crop.

Kalyan Chakrabarti*
and
Siddharta Barari**

* Conservator of Forests,
Research Circle,
Calcutta (West Bengal)

**Divisional Forest Officer,
Silviculture (South) Division,
Midnapore (West Bengal)

(II)

A PERFORMANCE TRIAL OF IRRIGATED *ACROCARPUS FRAXINIFOLIUS*, WIGHT PLANTATION IN CHIKALDARA PLATEAU OF MAHARASHTRA

Introduction

Acrocarpus is a very large deciduous tree. Its heartwood is light red, moderately hard and used for tea-boxes, furniture and building. It is one of the largest trees in India (Troup, 1921).

Acrocarpus and *Grevillea robusta* are the two common species used for plantation in Chikaldara Plateau. Chikaldara is the only hill station in Vidarbha Region of Maharashtra. Under a beautification project, some plantations of *Acrocarpus* were undertaken during 1992 rain in Chikaldara Plateau. The objective of this study was to assess the effects of irrigation on growth and biomass production in *Acrocarpus* plantation.

Materials and Methods

The study site is located from 21° 20' - 21° 45' N latitude and 76° 45' - 77° 30' E longitude, at 1130 m elevation in Chikaldara Plateau. Of the total annual rainfall (1500 mm), about three quarters occurs during June to September. Mean daily temperature ranges from 11°C to 35°C. The tract is situated on the branch of Satpuda ranges to the South of Tapti River known as Gawilgarh Hills (named after Gawilgarh Fort) of Melghat.

During 1992 rain total 19.50 ha of *Acrocarpus* plantation was undertaken in Chikaldara Plateau. Seedlings were planted at 2 m x 2 m spacing. Out of 19.50 ha around 3.5 ha plantation was irrigated four times a month from 15th February, 1993 to 15th May, 1993. During the irrigation each seedling was provided with 2 litres of water. Remaining plantations were not irrigated and used in this study as control (Non-Irrigated). In total plantation one dose of 50 gm urea and two subsequent doses of 50 gm of NPK (18 : 18 : 18) were applied to each seedling in first year.

Five sample plots of 10 m x 10 m were laid out randomly in irrigated and non-irrigated plantation, each. Average initial height of seedlings used for plantation were 35 cm. After 15 months of the plantation height and collar girth of the plants were recorded. Data of height and collar girth were subjected to students t-test. For estimation of biomass one plant of average girth and height was selected and felled from each plot. Foliage, branches and stems were separated and their fresh weight recorded. Dry weight of each of the plant components was recorded after oven drying the leaf at 80°C and sun drying the stems and branches.

Results and Discussion

Result of the study is presented in Table 1. It is evident from the data that height and collar girth are significantly higher in irrigated plantation at 1% level of significance. Irrigation has increased the total biomass by five folds. Maximum

Table 1

Growth, Biomass Production and Cost of Biomass Production in Irrigated and Non-Irrigated 15-month old Plantation of Acrocarpus

	Non-Irrigated	Irrigated
Height (Mean ± S.D) (m)	1.17 ± 0.21	3.03* ± 0.35
Collar girth (Mean ± S.D) (cm)	7.43 ± 1.66	15.08* ± 1.43
Foliage Biomass (MT/ha)	0.2	1.20
Branch Biomass (MT/ha)	0.3	2.50
Stem Wood Biomass (MT/ha)	1.0	4.10
Total Biomass (MT/ha)	1.50	7.80
Cost of the Plantation (Rs.) (First Year)	8,500	15,000
Cost of the per MT Biomass Produced (Rs.)	5,666	1,923

*Significant at 1% level.

increase is seen in branches.

It is reported that *Acrocarpus* grows upto average height of 4.57 m and girth 27.68 cm in 9 years (Troup, 1921). In the present study is clear that irrigation can enhance the growth and biomass production significantly. The cost (upto first year) of the irrigated plantation was around Rs. 15,000 per ha as against Rs. 8,500 for non-irrigated plantation. In non-irrigated plantation weeding and soil working is required in second and third year, which costs around Rs. 4,000 per ha.

It is important to note that besides better growth and biomass production, irrigated plantation does not require any further operations in second and third year. Growth which is normally achieved in four to five years could be achieved in one year with irrigation, which leads to early establishment of the plantation. Once the plantation gets established then less attention is required for protection and maintenance. Besides this the cost of biomass production for per metric tonne (MT) is substantially less in case of irrigated plantation.

In view of the above facts, if intensive operation with irrigation is carried out in first year, it is possible to get well established plantation of *Acrocarpus* in one year and relieving the forest manager to concentrate on new plantations. However, this is a preliminary study, its long term economics and growth performance need further study.

Acknowledgements

The author wishes to express his sincere thanks to Shri Bhagwan, IFS., Deputy Conservator of Forests, West Melghat for valuable discussion and his staff for collecting the data.

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Dy. Conservator of Forests,
Buldhana Forest Division,
Buldhana (Maharashtra)

Mohan Jha

(III)

IS SAL MORTALITY RELATED TO GLOBAL CLIMATE CHANGE ?

Shorea robusta (Sal) is one of the most important tree species in India. The species has very high reputation for the excellence and durability of its timber.

Recently large scale mortality of its forests has been reported from various parts of Uttar Pradesh. In moist Sal forests e.g. Ram Nagar Forest Division (Bhakra 5D Comptt.) the dying is apparently caused by a root rot disease (*Shorea polyporeae*), but in larger areas of Dehra Dun Forest Division (Barkot Range), Lansdowne Forest Division (Laldhang and Kotri Range) and in Ram Nagar (Kaladhungi Range) no pathogen or insect has been reported from dying trees. In some of the areas trees are dying in gregarious patches. The apparent cause seem to be some kind of Eco-physiological related stress in the affected trees because of certain climatic changes in the region in the recent past, which has changed the climate amplitude of the species for its growth and making conditions favourable for other more drought tolerant species, thus posing stiff competition for Sal. In one such case in Kaladhungi Range of Ram Nagar Forest Division (Musa Bangar Comptt. 5) where large scale dying of Sal is occurring, the area is invaded by one of its associate Dum Sal *Miliusa velutine*. *M. velutine* is a common associate of Sal, sporadic in occurrence but not as gregarious as seen in this particular area of Kaladhungi Forest Range. This gregarious spread of *M. velutine* has been reported from past 10-15 years by local forest staff. On our personal enquiry from local folks, they are of the opinion that Sal in this area is dying since *M. velutine* has invaded these forests. Die back and large scale mortality of forest has been reported from some other parts of the world as well. In Kenya large scale die back and mortality upto 90% has been recorded since early 1980s in *Juniperus procera*. The heaviest damage has been reported in the drier lower elevation forests. The factors related for this conditions are unknown. Ciesla *et al.* (1994) hypothesized that these forests have been stressed by a long term regional warming and dying trend which was affected the low elevation sites to the point where they are no longer suitable for this species. The phenomenon of global climate change is perhaps also being experienced in Doon Valley. A six decades analysis of water balance of Doon Valley shows that annual averages of rainfall and surplus values have decreased from first 3 decades to the latter three decades (Rawat and Rawat, 1995). Surplus value was lowest during the last decade (1981-90) as compared to earlier decades.

The degree of inter-species competition is greatest in high diversity forests. Plant species have complex pollination and dispersal strategies making them more vulnerable to the effects of change outside the range of their normal experience. As a consequence of this intensive biological organisation, high diversity forests may be expected to collapse towards species poor association when faced with effect of rapid climate change (Sorensen, 1994).

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Forest Ecology and Environment Division,
Forest Research Institute,
Dehra Dun (India)

Vijay Rawat
and
J.D.S. Negi

(IV)

A NOTE ON TWIN SEEDLINGS IN *CALOPHYLLUM INOPHYLLUM* (LINN.)

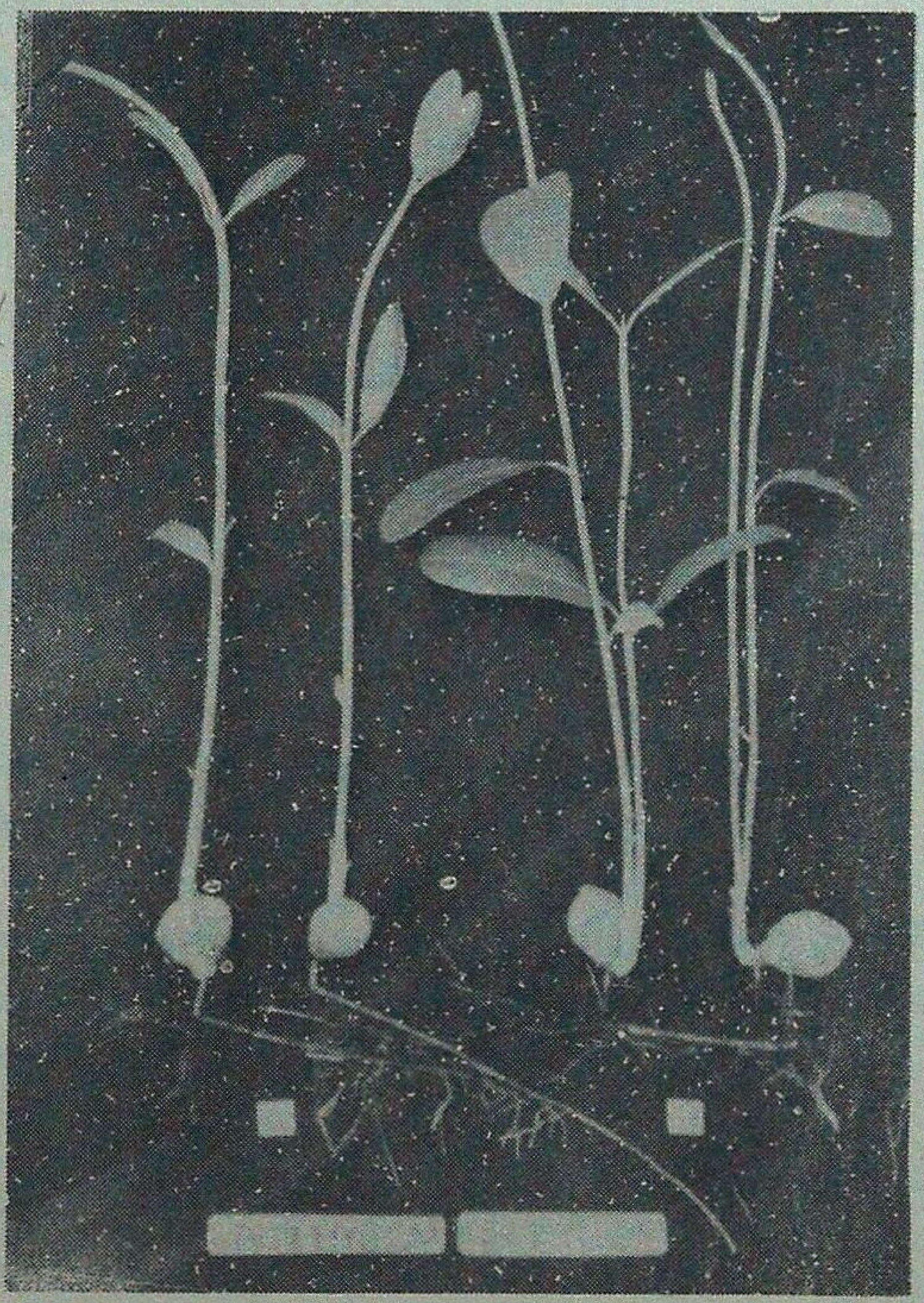
Calophyllum inophyllum (Linn.) is an evergreen tropical tree occurring along the sea coasts of the Indian peninsula, the Andaman and Nicobars. It is widely planted as an avenue tree. The timber is sought after for masts and spars and bridge construction. The tree bears oil seeds from which edible oil is extracted but its usage is still unexplored. Seedlings of this species are raised in nurseries on a large scale mostly for afforestation along the road sides (Troup, 1975). This note deals about the abnormal twin seedlings noticed during the germination studies of *C. inophyllum* under nursery conditions.

The fruits were collected during the month of April 1997 from a fifteen year old tree. A total of 100 seeds were sown in polypots filled with nursery mixture i.e., soil, sand and farm yard manure in the ratio 3 : 1 : 1. Germination commenced 18 days after sowing and out of the 45 germinated, 4 twin seedlings were recorded on the 21st day. The twin seedlings observed in this study are due to polyembryony which has not so far been reported in *C. inophyllum*.

Similar records of twin seedlings were reported in other tree species viz., *Dalbergia sissoo* (Kumar *et al.*, 1977); *Bombax ceiba* (Venkatesh and Emmanuel, 1978); *Pongamia pinnata* (Purohit and Jamaluddin, 1987); *Pterocarpus marsupium* (Shrivas and Bajpai, 1990); *Bauhinia purpurea* (Philomina *et al.*, 1995) and *Bambusa arundinacea* (Kumar *et al.*, 1995).

The twin seedlings were fused in the collar region of the hypocotyl. They exhibited stunted growth, smaller cotyledons and poorly developed root system when compared to the normal seedlings. The twin seedlings when separated and planted in polypots died after 4 days.

Fig. 1



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Forest College and Research Institute,
Mettupalayam (Tamil Nadu)

K. Kumaran,
S. Umesh Kanna and
Joseph Anton Amal

From the Indian Forester - One Hundred Years Ago

THE
INDIAN FORESTER
September, 1898 (PP.350-51)

IRON SMELTING WITH CHARCOAL IN SALEM DISTRICT, MADRAS.

The industry, if it is to be developed, I mean if the manufacture of iron is to be conducted locally, will have to be confined to the Tirtamalai beds. From the statement appended to Mr. Brasier's office-note, No. 2445, dated 23rd October 1897, he now estimates that within a radius of 16 and 25 miles respectively, there will be 224,250 and 288,642 acres of reserved and proposed reserved forests available for the manufacture of charcoal.

These forests have been less indented upon; the growth is, for the most part, denser than in the forests near the Kanjamalai beds, and there is little doubt the average annual increment is greater. Mr. Brasier estimate the latter at three-fourths of a ton per acre per annum. This estimate will probably be realized, but in the commencement it will be safer to assume half a ton per acre per annum as the average annual increment.

The area mentioned previously will have to be reduced to exclude rocky, bare and unworkable parts, and 25 per cent. may be accepted as a fair margin. This reduces the workable area to about 168,000 and 216,400 acres respectively. Further deductions are necessary. Parts of these forests contain valuable woods which would not be felled for charcoal. In addition, in places, provision may have to be made for local requirements. It has also to be borne in mind that fuel as well as charcoal will be required. I consider it will not be safe to accept more than 120,000 and 160,000 acres (according to the adoption of the 16 or 25 mile area) as available for charcoal manufacture.

The average annual yield would therefore be 60,000 and 80,000 tons of wood, or 12,000 and 16,000 tons of charcoal (allowing 5 tons of wood to yield 1 ton of charcoal).

The system generally, of working these forests would be coppice with retention of a percentage of the more valuable trees as standards, and it would not be advisable, until further experience has been gained, to adopt a shorter rotation than thirty years.

Mr. Brasier estimates the cost of the charcoal at Rs. 12-12-0 for the 16-miles areas :-

	Rs.	A.	P.
Cost of billetting, &c. 5 tons of wood at Rs. 1.8.0	7	8	0
Piling wood in kilns and general supervision ... ... (I see no reason to question these. Mr. Brasier has had great experience and is well acquainted with the local rates.)	0	8	0
Interest on outlay for rough cart-tracks ... ... (Assuming that the outturn is only 10,000 tons annually, this would allow Rs. 10,000 for roads.)	1	0	0
Carriage of 1 ton an average distance of 8 miles, Rs. 1.12.0 ... ... (This is a doubtful factor and depends upon the position of the furnaces. I would increase Mr. Brasier's rate by As. 8 to allow for increased distances.)	2	4	0
Seigniorage ... ... (Mr. Brasier's estimate is, I consider, too low. Annas 8 per ton of wood or Rs. 2.8.0 per ton of charcoal is not a high seigniorage.)	2	8	0
Sundries (loading and unloading charcoal)	0	8	0
Cost of general supervision	0	8	0
Total cost per ton of charcoal	14	12	0

One point to be noticed is the transfer of the work to the Tirtamalai beds entails carriage to the railway, some 14 miles.

(Report by E.P. Popert, Conservator of Forests.)

LETTERS TO THE EDITOR
(I)

To,
Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Sub : **Those Days**

Dear Sir,

The year was 1952 and the month was December. Nature in the sub-Himalayan Tarai is at its best during this period. Trees with many hues of leaves and fragrant flowers. Rapids with sparkling water and rivers flowing smoothly through the deep dense forests. The forests are live with songs of birds and roars of animals. It is a bliss to walk through these beautiful forests. It is beauty surpassing all beauties. And the unbelievable thing is that I used to get paid for enjoying such beauties of Nature : instead of paying for the privilege. I was and have been a professional forester. At that period of time I had completed my back breaking training at the Indian Forest College and was at the initial stage of my in-service training as Assistant Conservator of Forests. I was posted in the Buxa Forest Division covering the Forests in the sub-Himalayan Tarai known as Eastern Dooars.

Those were the days of production forestry. Harvesting of selected mature and over-mature trees was a management policy. These trees have ceased to put on desired rate of growth and their removal would provide space for younger plants. Under this silvicultural system, I was required to select and mark the trees in virgin forests of Panbari block. There was a dense crop of large trees of Sal, Champ, Gamhar, Paccasaj, Chapalasha, Lali, Lahsunne, Ficus of many species, as well as variety of other trees, shrubs, herbs, climbers and canes - these occupied all available space both vertically and horizontally. It was impossible for the sun's rays to penetrate this dense canopy. Thus inside the forest it was dark and cool. Forest floor was wet and in places water was oozing out from the ground and trickling down over forest floor with a soft murmur. Trees felled by cyclonic wind and over-mature fallen tree trunks were all covered with thick moss and fungi of different varieties. One has to be careful not to disturb a snake or a resting animal as there is danger of strike back out of fear for self defence. Man is a trespasser in such virgin forests which is home for many wildlife. A great deal of care and caution is necessary to explore these dense wet forests. In course of my selection markings, I came across one herd of Bison, numerous Deers, two Pythons, variety of birds two herds of Boar, one Bear. My meeting with Elephants and Tiger during this exercise I would narrate in detail.

As the work progressed we had to enter more and more into the interior of the dense forest. This provided us with opportunity to observe various animals in undisturbed condition in their habitats. However, our meeting with a herd of about twenty Elephants in a rivulet flowing by the roadside was quite thrilling. The encounter compelled me to make a long detour to reach my forest rest hut. These huts are usually made of local wood placed atop strong wooden posts and at 3 m to 4 m above ground level, thus providing safety, security and hygiene.

My encounter with the king of the forests was in a very novel manner. One day after work I was cycling back to my camp. It was about 4 O'clock in the afternoon. The golden rays of the winter sun was visible only at the tops of the large trees. There were deep shadows in the forest. I was cycling monotonously while my attention was attracted by the chirping of hundreds of Mynas on a large Ficus tree. Unmindfully I passed a sleeping animal considering it to be a village cattle. Suddenly some sixth sense alerted me and I looked back. Then I froze. A magnificent Royal Bengal Tiger was comfortably sleeping on the grass turfed road. What a narrow escape I had by not disturbing His Majesty. It was rather unusual for him to be sleeping at this time of the day in a high forest. This is usually the time to stalk and hunt. May be it had made a kill and was a satiated animal after a good meal. However, I could not get any smell of a dead animal. Also, I had no intention to investigate. After another good look, I continued to cycle back to my camp.

Anticlimax

Decades later in 1985 as the head of the Forest Department of the State, I spent hours in the same forests of Buxa Division, eagerly searching for a look of the great animal but the royalty did not oblige. I hope that with the care provided by creation of a Tiger Reserve in these forests, things have improved.

Sd/- Dilip K. Ganguly, I.F.S. (Retd.)
DB-98, Sector - 1,
Salt Lake City,
Calcutta (West Bengal)

(II)

To,
The Hony. Editor
The Indian Forester,
P.O. New Forest
Dehra Dun (UP)

Sub : **Some observations on *Ailanthus excelsa* in Orissa**

Sir,

Ailanthus excelsa is common in the interior parts of Orissa. About three decades back, its occurrence in the coastal tracts was rare. The species is now spreading fast in these tracts.

It plants are normally not browsed by cattle. The trees are not ordinarily hacked. Rather the trees standing by the sides of the highways and on open grounds are favoured because they provide shade during summer.

The species thrives on a variety of soil conditions. Flowering and fruiting take place every year. Fruit-ripening synchronizes with the onset of the monsoon. Germination is not a problem. Other conditions required for good growth and development of *A. excelsa* exist in Orissa.

Its wood is hardly used in this State except, to a very limited extent, in making rafts for fishing in the sea. If the quality of wood of this species can be improved by compressing and impregnating it with proper chemicals so that the wood can be used as timber and if the wood can be used in manufacture of paper and board, large scale plantations of this species can be raised in Orissa.

Yours faithfully

Sd/-
Sudakar Mohapatra
Former Chief Conservator of Forests
& Wildlife Warden,
Orissa

REVIEW

The Book of Indian Trees by Prof. K.C. Sahni, Pubs. Bombay Natural History Society and Oxford University Press, Mumbai (1998) pp x-230 with 20 plates and 70 figs. Price Rs. 275.00.

The Book of Indian Trees by Prof. K.C. Sahni expresses his deepest devotion and total commitment to the components of the biodiversity and genetic resources of India and adjacent countries. During recent times, several books on the trees of different regions of the globe have been written but the attention on the tree species both typical and little/less-known has not been focused. Prof. Sahni by his inimitable style for which he is well known to his students of Botany and Forestry throughout India has instilled best out of his vast experience in the subject. Typical manner of writing in a lucid way with use of words easily understandable to both layman and those with a scientific background makes the book absorbing and compels one to turn and read its pages at breakfast and at bed time.

Principally, the book comprises of a preface, a detailed introduction, descriptions of 153 species, line drawings and silhouettes by world renowned botanical artist, P.N. Sharma expressing diagnostic features of 81 species, coloured plates of 17 species contributed largely by Dev Raj Agarwal, a well know plant photographer. A result chapter on "Know Your Tree" contains field and diagnostic characters that aid quick identification. There is a glossary of technical terms, field and diagnostic characters of species represented by 54 families of forestry and wildlife interest and a bibliography covering references related to the studies on Indian trees. Nomenclature of species is upto date. Important vernacular and English names have been provided to all the taxa and the text has been fashioned at par with that of Dr. Salim Ali's famous *Book of Indian Birds*. This makes the book a handy companion. Several species exotic to India have been explicitly dealt with. Exotics like Jacaranda, Gulmohar etc. have been excluded as these are described in *Flowering Trees* by M.S. Randhawa and other Indian works. This was necessary as mentioned by the author to include as many native trees as possible. Details on associates, propagation and etymology have not been adhered uniformly to several species but suitably substituted by other facts such as little or less known uses, brief sketch of history of discovery of the species, affinity with other taxa, etc. Six species of bamboo that are considered as 'tree grasses' have been incorporated in the account. Miscellaneous notes are full of fascinating comments covering various aspects. Several vernacular names seem to have been symbolically coined by the author in this book e.g. Arunachal pine (*Pinus bhutanica*), Rhino bamboo (*Dendrocalamus hamiltonii*), Indian Willow (*Salix tetrasperma*), Tiger Tree (*Bischofia javanica*), Mangrove (*Bruguiera gymnorhiza*). As mentioned in the text, Arunachal pine was first discovered by the author and later by the British as admitted by them.

The get-up of the book deserves appreciation, it is well bound and neatly printed. The quantum of information the treatise embodies and the line sketches, silhouettes and coloured plates provided, the price of the book is low and affordable by students of Botany and allied subjects. This book should be of interest for the wildlife enthusiasts, as many associated animals are cited the most outstanding of which is *Cullenia exarillata* of S. India, the fruit of which is relished by the endangered Lion-tailed Macaque. Another interesting mention is the Talipot palm with the largest inflorescence with 60 million flowers. This work should be useful to all levels of forestry students, IFS probationers and foresters in India and adjacent countries. The work is timely as 'Tree and Environment' is now a compulsory subject in schools and colleges as per recent orders of the Government of India.

(P. Keswani)

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

Shri P. Chandramanoharam, I.F.S. (79), Conservator of Forests (Project Formulation Circle), Hyderabad who stands posted as Conservator of Forests, Social Forestry Circle, Cuddapah is posted as Conservator of Forests, Warangal Circle vice Shri B. Muralikrishna, I.F.S. (81) transferred.

Shri S.V. Kumar I.F.S. (78), Conservator of Forests, Wildlife Management, Tirupathi, is transferred and posted as Conservator of Forests, Guntur Circle vice Shri C. Muralidhara Rao, I.F.S. (76) transferred.

Shri N. Shyam Prasad, I.F.S., who is waiting for posting is posted as Divisional Forest Officer, Chittoor (West) Division vice Shri Sunil Kumar Gupta, I.F.S. (87) transferred.

On transfer, Shri Sunil Kumar Gupta, I.F.S. (87) Divisional Forest Officer, Chittoor (west) Division is posted as Deputy Conservator of Forests (Inventory), Office of the Conservator of Forests, Warangal Circle in the existing vacancy.

Shri B. Balakrishna, I.F.S., who is waiting for posting is posted as Divisional Forest Officer, Khammam Division vice Shri Lokesh Jayaswal, I.F.S. (87) transferred.

On transfer, Shri Lokesh Jayaswal, I.F.S. (87) Divisional Forest Officer, Khammam Division is posted as Deputy Conservator of Forests (Inventory), Office of the Conservator of Forests, Ananthapur Circle in the existing vacancy.

Shri Vipin Chowdhary, I.F.S. (86) who stands posted as State Silviculturist, Hyderabad is posted as Divisional Forest Officer, Kothagudem Division vice Shri. R.P. Khajuria, I.F.S. (91) transferred.

On transfer, Shri R.P. Khajuria, I.F.S. (91) Divisional Forest Officer, Kothagudem Division is posted as State Silviculturist, Hyderabad vice Shri I. Peraiah, S.F.S. Officer transferred.

Shri Lokesh Jayaswal, I.F.S. (87), Divisional Forest Officer, Khammam who stands posted as Deputy Conservator of Forests (Inventory) Office of the Conservator of Forests, Ananthapur circle is posted as Divisional Forest Officer, Atmakur vice Shri A.K. Jha, I.F.S. (92) deputed to attend 10 months P.G. Diploma Course at Indian Institute of Remote Sensing, Dehra Dun.

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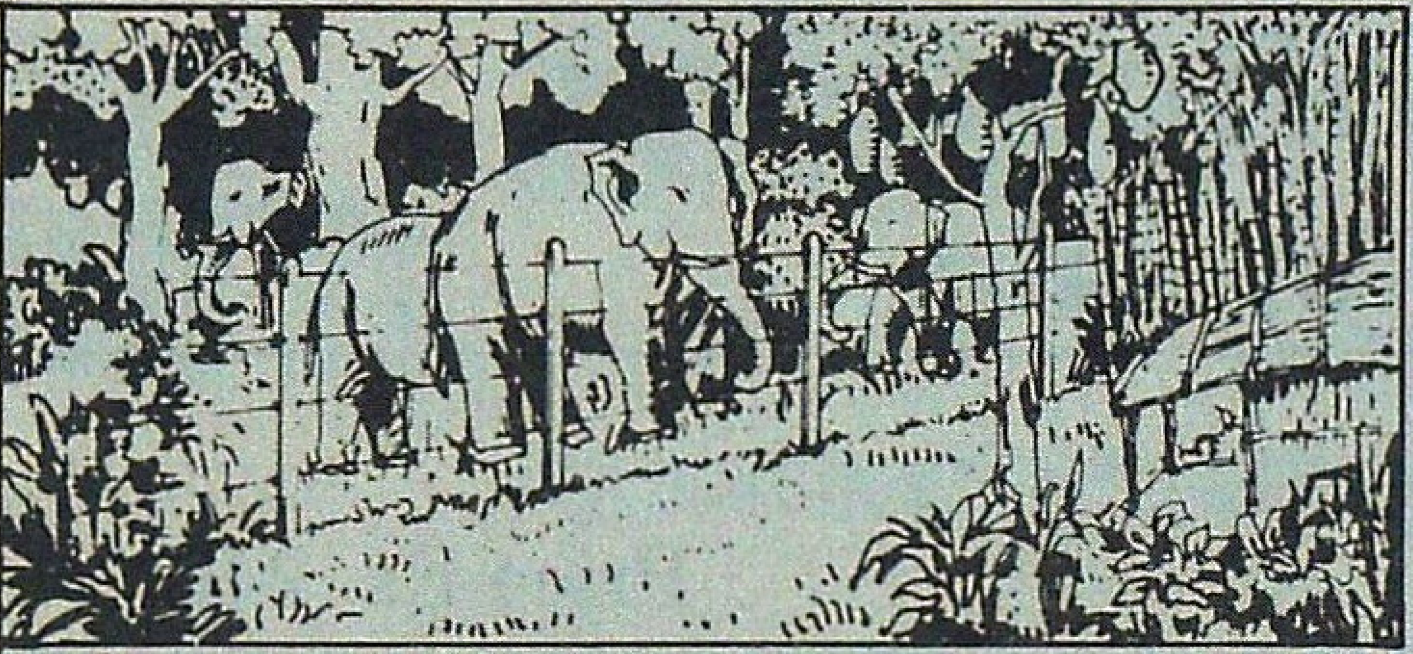

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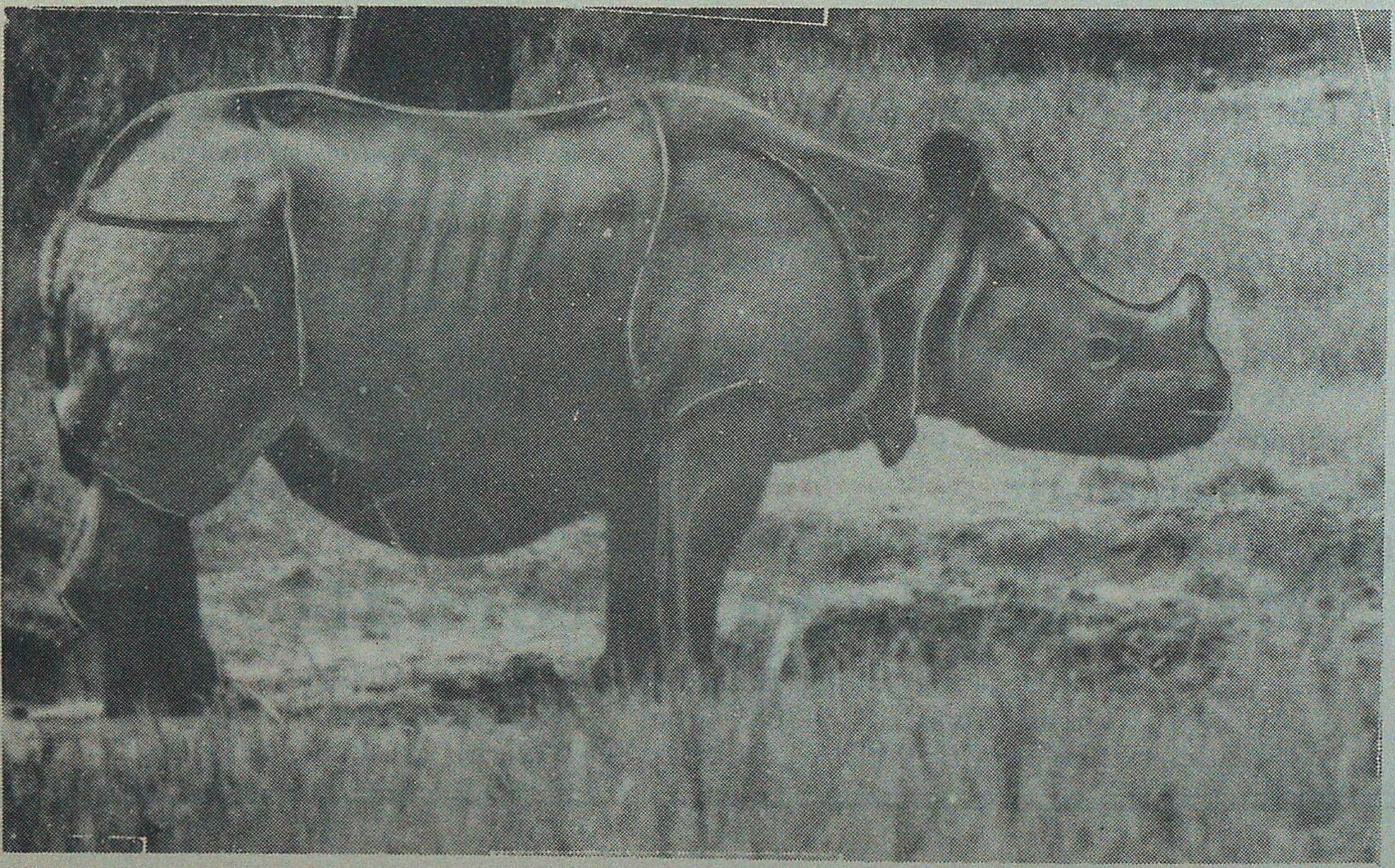

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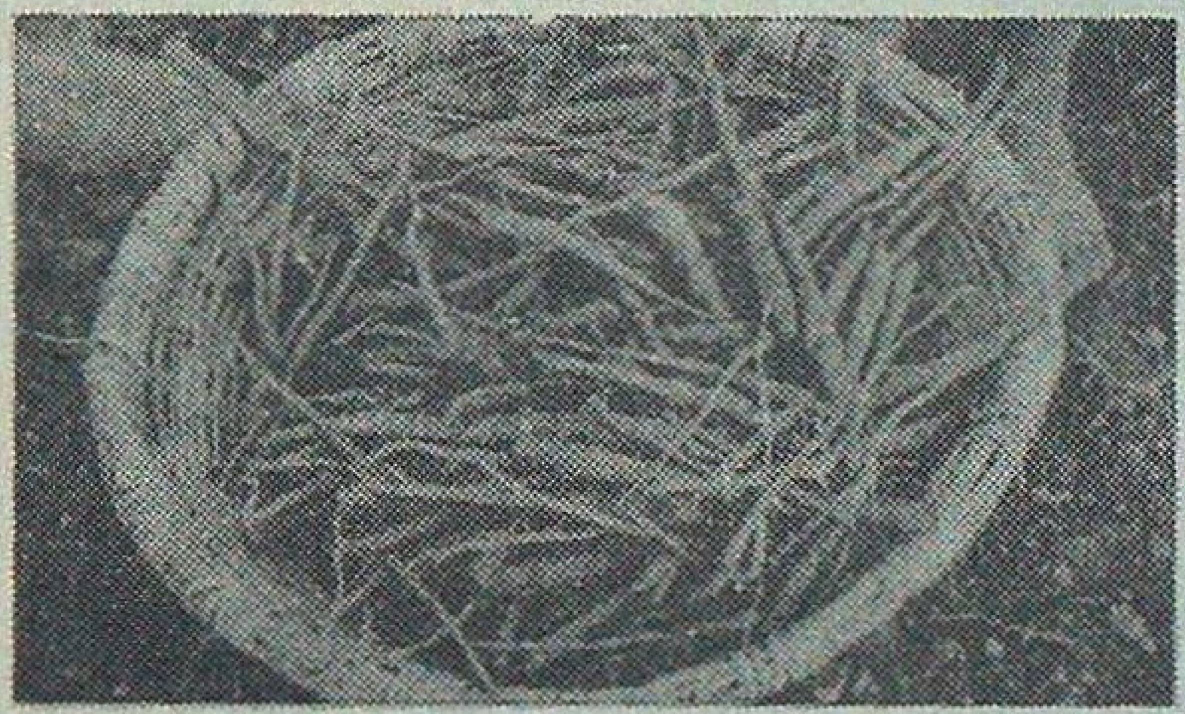

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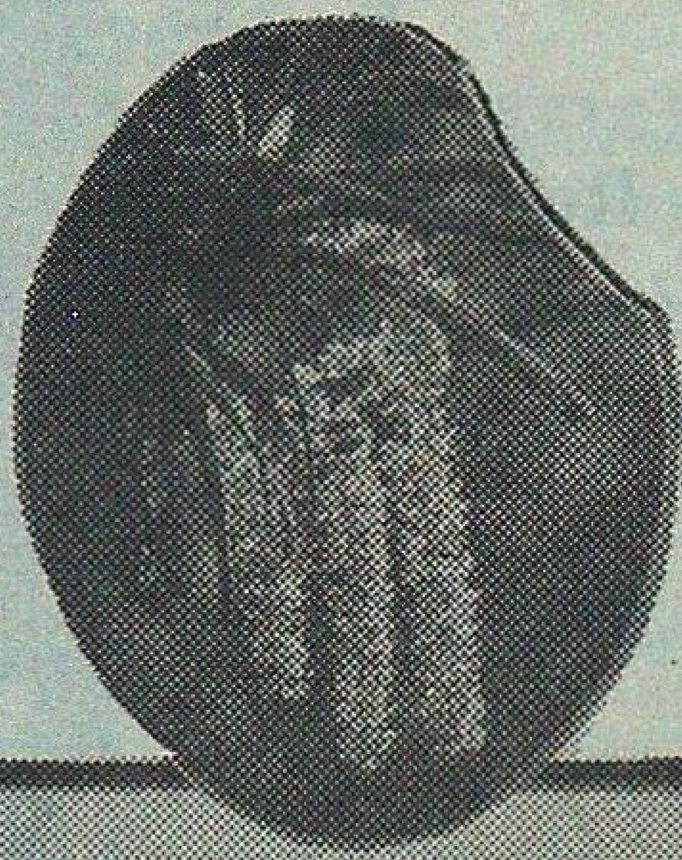

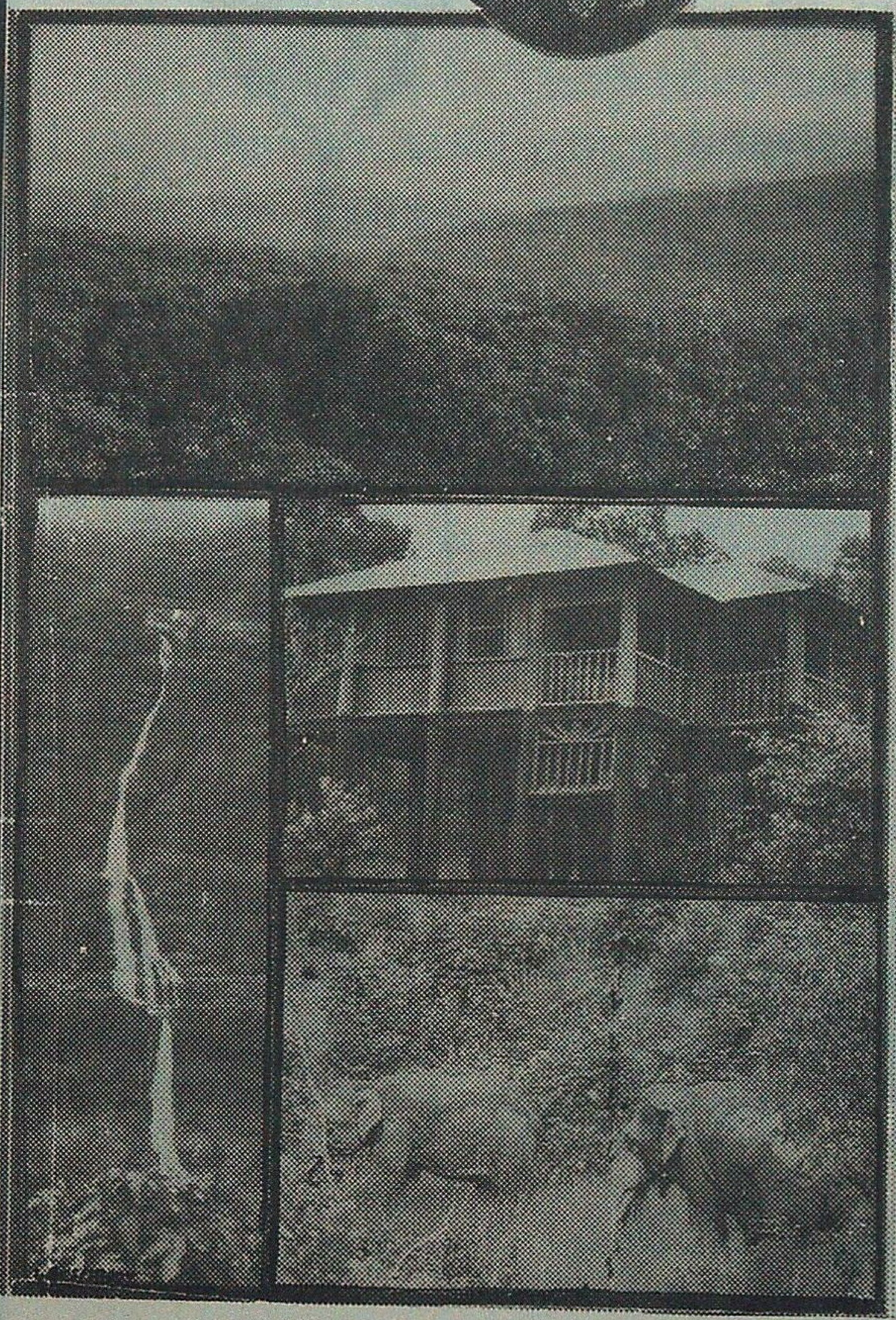

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- जड़ से चेतन का बोध कराते हैं स्लोगन लेबिल
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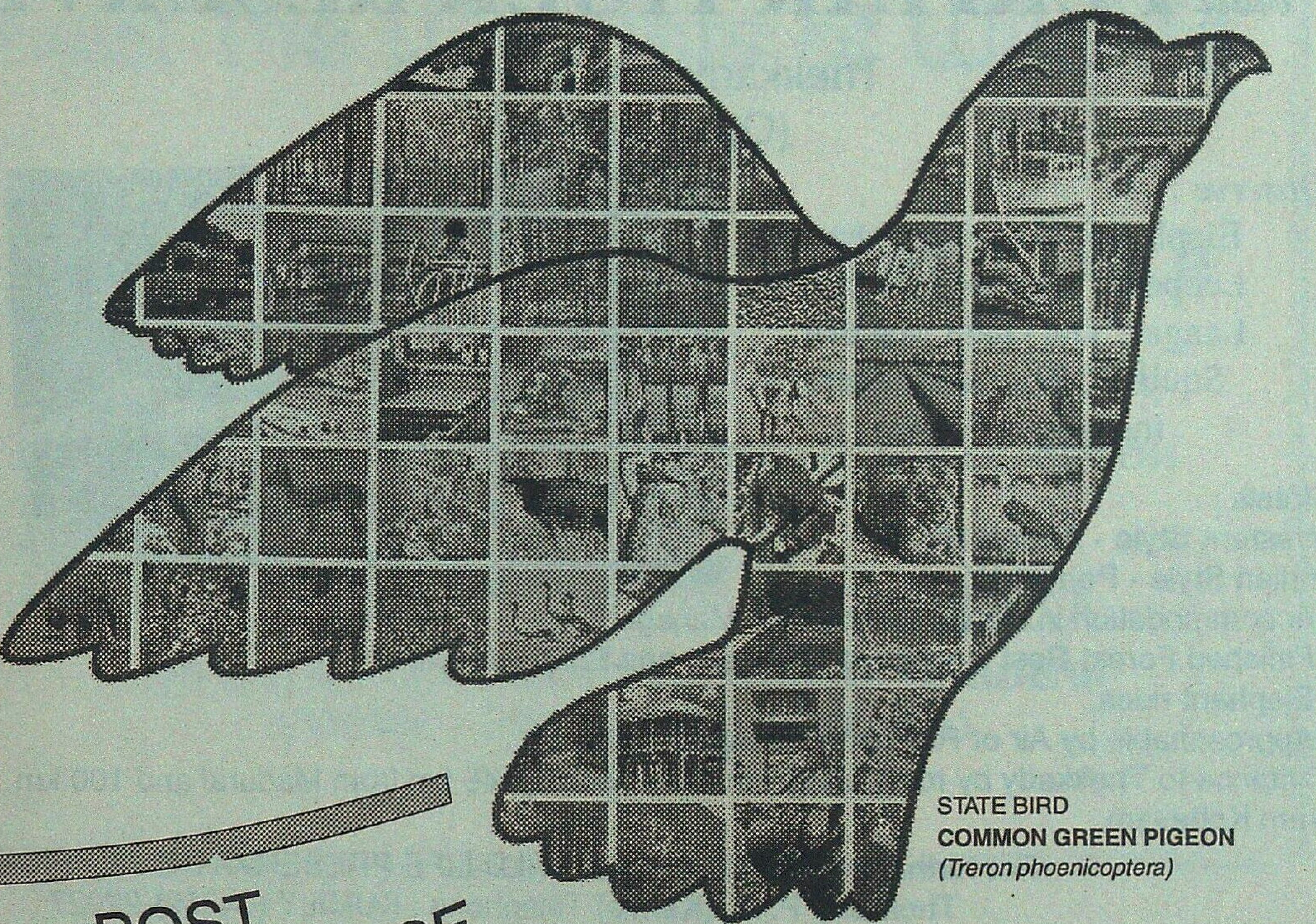
आपको कौन से स्लोगन लेबिल कितने-कितने चाहिएँ सूची की जिरोक्स करवाकर, लिखकर भिजवायें जिससे कि वे ही स्लोगन लेबिल भिजवाए जा सकें।

कोड नं.	स्लोगन लेबिल	संख्या	कोड नं.	स्लोगन लेबिल	संख्या	कोड नं.	स्लोगन लेबिल	संख्या
C113.	वन वरदान है		C149.	पेड हमारी शान हैं, जीवन की मुस्कान है		C185.	नही तनिक भी भार पेड़ हैं, पशुओं का आहार पेड हैं	
C114.	वन ही धन है		C150.	आज समय की यही पुकार, बच्चे दो और वृक्ष हजार		C186.	स्वच्छ बने तन मन संसार, भू पर हों जब पेड अपार	
C115.	चार धाम, एक आम		C151.	पृथ्वी पर है स्वर्ग वहाँ, हरे भरे हो वृक्ष जहाँ		C187.	आओ अपनी भूल सुधारें, पर्यावरण का रूप निखारें	
C116.	शुद्ध वायु, करे चिरायु		C152.	नगरी नगरी द्वारे द्वारे, पेड लगाओ न्यारे न्यारे		C188.	सब दुखों के तरु परिहारी, मंगल करन अमंगल हारी	
C117.	वृक्ष एक, लाभ अनेक		C153.	जहाँ जहाँ है हरियाली, वहाँ वहाँ है खुशहाली		C189.	वृक्षारोपण का यह पैगाम, होगा स्वस्थ सुखी इन्सान	
C118.	वृक्ष वृद्धि, सर्व समृद्धि		C154.	हमको चाहिये शुद्ध हवा, वृक्ष लगाना ही है सही दवा		C190.	जन जन को यही बताना, पर्यावरण को शुद्ध बनाना	
C119.	पृथ्वी का श्रृंगार है वृक्ष		C155.	जब पृथ्वी हो वन मय, तो जीवन हो अमृतमय		C191.	धरती का श्रृंगार सजाओ, वृक्ष लगाओ-वृक्ष लगाओ	
C120.	वृक्ष लगाएं देश बचाएं		C156.	जन-जन को बतलाना है, सबको पेड़ लगाना है		C192.	काट रहे वन, ज्ञान नहीं है, जीवन की पहिचान नहीं है	
C121.	वृक्ष राष्ट्र की सम्पत्ति है		C157.	पेड अधिक है जहाँ जहाँ, वायु शुद्ध है वहाँ वहाँ		C193.	फैलेगी घर घर खुशहाली, छायेगी जब सर्वत्र हरियाली	
C122.	एक बच्चा, एक वृक्ष		C158.	बढता हुआ वृक्ष देश की प्रगति का द्योतक है		C194.	घटते वन बढती विपदायें-पेड़ न काटे, नये लगायें	
C123.	वृक्ष ददाति ऐश्वर्यम्		C159.	नन्हा पौधा बनता पेड़, सुख सम्पदा देता ढेर		C195.	गाँव गाँव अभियान चलाओ, डगर-डगर पर वृक्ष लगाओ	
C124.	वृक्षारोपण युग धर्म है		C160.	वनीकरण आज की प्राथमिक आवश्यकता है		C196.	पर्यावरण का संरक्षण देना, धरती माँ का मान बढ़ाना	
C125.	वृक्ष कटा, जीवन मिटा		C161.	बंजर धरती करे पुकार, पेड़ लगा, करो श्रृंगार		C197.	पर्यावरण को शुद्ध बनाओ, जीवन में खुशहाली पाओ	
C126.	वृक्ष लगाना, धर्म हमारा		C162.	वर्षा को बुलाते पेड़, सावन में झुलाते पेड		C198.	अगर चाहिए लम्बी आयु, सेवन करें स्वच्छ जल-वायु	
C127.	सरसे वन, तो बरसे धन		C163.	पेड़ भूमि का है श्रृंगार, रोको इन पर अत्याचार		C199.	जन जन का हो एक ही नारा, पर्यावरण हो शुद्ध हमारा	
C128.	वृक्ष जीवन के आधार है		C164.	वृक्ष देते स्वच्छ वायु, सुखी जीवन लम्बी आयु		C200.	आओ मिलकर वृक्ष लगायें, इस धरती को स्वर्ग बनायें	
C129.	धरती के परिधान हैं वृक्ष		C165.	वृक्ष भूमि का गहना है, जन जन से यह कहना है		C201.	धूल, धुएं का बढता जंगल, मानवता का हुआ अमंगल	
C130.	पेड़ लगाएं सुख उपजाएं		C166.	चारों ओर होगी समृद्धि, पौधों में जब होगी वृद्धि		C202.	बढ़ता प्रदूषण, घटती आयु, कारण एक अशुद्ध जलवायु	
C131.	एक वृक्ष दश पुत्र समाना		C167.	शिव समान विष पीते वन, कामधेनु सा देते धन		C203.	आओ मिलकर वृक्ष लगाएं, पर्यावरण को स्वच्छ बनाएं	
C132.	वन है तो मानव जीवन है		C168.	आओ सुन्दर देश बनाएं, हरे भरे हम पेड लगाएं		C204.	नष्ट हुई जो वृक्ष की छाया, छा जायेगी अकाल की माया	
C133.	वन है सोना, इसे न खोना		C169.	पेड़ हमारे जीवन दाता, इनसे अपना गहरा नाता		C205.	स्वच्छ हवा, नीला आकाश, हरियाली का करो ना नाश	
C134.	वृक्षों के रक्षक बने, भक्षक नहीं		C170.	वृक्ष जगत का है आधार, करो न इन पर अत्याचार		C206.	घर आंगन में पेड लगाओ, वातावरण को स्वच्छ बनाओ	
C135.	औषधियों के आधार हैं वन		C171.	कहते हैं सब वेद पुराण, बिना वृक्ष के नहीं कल्याण		C207.	वन से तन है, वन से मन है, वन से जन है, वन से धन है	
C136.	वृक्ष लगाना नैतिक कर्त्तव्य है		C172.	सबसे बडा है धर्म अपना, पेड पौधों की रक्षा करना		C208.	वृक्षों की रक्षा प्राणों से ज्यादा, जीवों की रक्षा अटल ईरादा	
C137.	वृक्ष ही ऊर्जा संकट का समाधान है		C173.	वृक्ष हमारा जीवन साथी, कहें इसे जीवन की थाती		C209.	धूल धुआँ बढता शोर, प्रकृति चली विनाश की ओर	
C138.	हरियाली लाइये, खुशहाली पाइये		C174.	हरा वृक्ष है जीवन दाता, प्राण वायु और वर्षा लाता		C210.	वृक्ष हमारे फेफडे हैं, इनको स्वस्थ रखिए और स्वयं भी स्वस्थ रहिए	
C139.	लहलहाते वृक्ष राष्ट्र की प्रगति दर्शाते हैं		C175.	छाया के सम्राट पेड़ हैं, फल-फूलों की खान पेड़ हैं		C211.	पेड लगाओ आ मन में लो ठान, पेडो में ही रहते हैं जीव जन्तु के प्राण	
C140.	जीवन दाता, वृक्ष विधाता		C176.	देशरी सुरक्षा सिपाही करे, खेतरी सुरक्षा पेड करे		C212.	चले शान से जीवन नैया, पर्यावरण स्वच्छ जब हो भैया	
C141.	वृक्ष लगाओ, जीवन पाओ		C177.	मत लो तुम वृक्षों की जान, धरती होगी रेगिस्तान		C213.	बिन जंगल बादल नहीं बरसे, बिन पानी सब प्राणी तरसें	
C142.	वृक्ष लगाओ, पुण्य कमाओ		C178.	गांव नगर में होवे वन, सुखी समृद्ध होवे जन जीवन		C214.	जन आन्दोलन इसे बनायें, अधिकाधिक सब वृक्ष लगायें	
C143.	दूषित गैसों के विष को पीते है वृक्ष		C179.	पेड़ हैं जीवन के आधार, ये हैं शुद्ध वायु के भण्डार		C215.	घर-घर यह अभियान चलाओ, डगर-डगर पर वृक्ष लगाओ	
C144.	सिर सांटे रूँख तो भी सस्तो जाण		C180.	पानी, पेड़ और शुद्ध हवा, जीवन की अनमोल दवा		C216.	यदि करना चाहो दूर प्रदूषण तो भूमि को पहनाओ वृक्षाभूषण	
C145.	वन ही प्राणियों के जीवन आधार हैं		C181.	तब ही सुखी रहेगी काया, जब होगी पेडों की छाया		C217.	घणा रुखड़ा घणी हरियाली, घणी बरसात देशरी खुशहाली	
C146.	पौधा प्राणवान है, उसे प्रेम की अपेक्षा है		C182.	पेड़, पौधे और वनस्पति, यही है जीवन की सम्पत्ति		C218.	वृक्ष है तो मेघ है, मेघ है तो जल है, जल है तो अन्न है, अन्न है तो जीवन है	
C147.	वृक्षारोपण दीर्घावधि की बचत योजना है		C183.	पर्यावरण पर करो विचार, इसी में है जीवन का सार		C219.	रूँख भयला आपणा, करो इणरो सम्मान, प्रति फल में जीवन सुरक्षा, देणो इणरों काम	
C148.	शांति के दूत पेड है, कमाई के पूत पेड़ हैं		C184.	पेड-पौधों का करो सम्मान, ये हैं ईश्वर के वरदान		C220.	मूल ब्रह्मा, त्वचा विष्णुः, शाखाः रुद्रो महेश्वरः पत्रे-पत्रे तु देवानाम वृक्षराजो नमोस्तुते	

NAVAL DAGA, **KRISHI VYAWASTHA,** 366, JOHARI BAZAR, JAIPUR-302 003 (RAJ.) 0141 (O) 560937,563814 (R) 521221, 521703 FAX : 521485

100 प्रजातियों के 200 ग्राम प्रति प्रजाति, कुल 20 किलो आपकी अपनी पसंद के वृक्ष बीज मात्र 1000 रु. में उपलब्ध हैं।



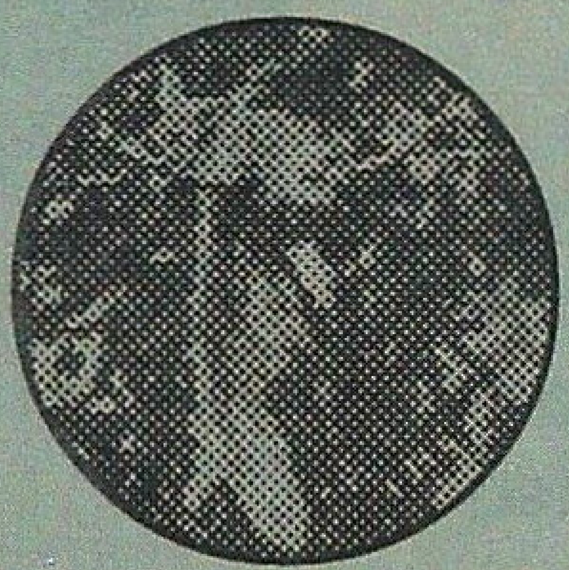
STATE BIRD
COMMON GREEN PIGEON
(Treron phoenicoptera)

POST
INDEPENDENCE
MARCH

OF MAHARASHTRA FOREST DEPARTMENT

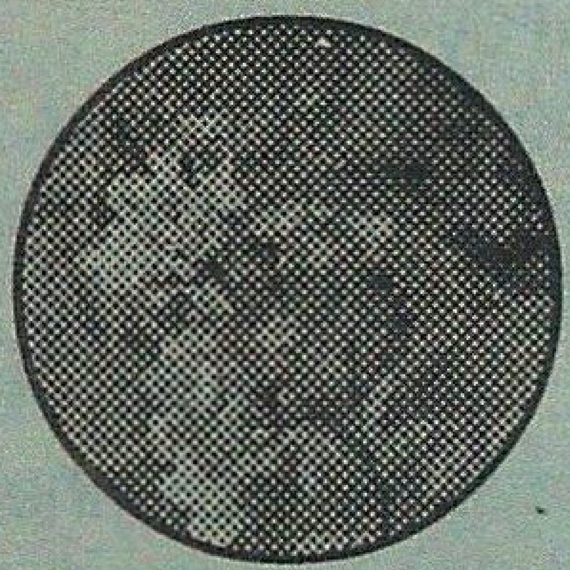
Maharashtra is a leading state in India. Industrial and population growth in last 50 years has ultimately put tremendous pressure on forest land. To overcome this pressure State Forest Department has undertaken many schemes for maintaining Environmental Balance including Wildlife Protection, Tribal Development, Soil and Moisture Conservation, Forest Protection. Maharashtra is a pioneer state to implement Forestry Project with the help of World Bank. An outlay of this project is to the tune of Rs. 431 Crorers for a period from 1992 to 1998. The project emphasize on Joint Forest Management, strengthening of Wildlife Wing, Production Forestry etc. Thus the development of Maharashtra Forest Department is based on multifaceted activities. Creation of National Parks 'and Sanctuaries have helped scientific management of wildlife and congenial environment for endangered species in the state. The efforts have received appreciation at international level also !

STATE ANIMAL



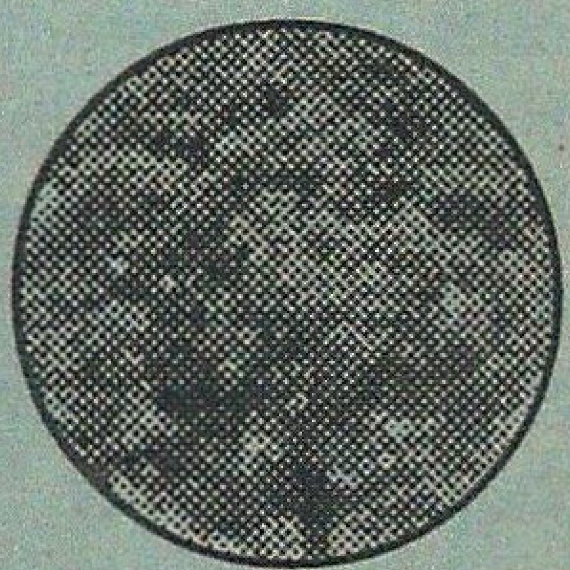
INDIAN GIANT SQUIRREL
(Ratufa indica elphinstoni *[Bhimashankar]*)

STATE FLOWER



JARUL
(Lagerstroemia *speciosa)*

STATE TREE



MANGO
(Mangifera indica)

PUBLICITY AND INFORMATION WING
FOREST DEPARTMENT,
MAHARASHTRA STATE
47/2, PUNE-SATARA ROAD,
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For further particulars contact : WILD LIFE PRESERVATION OFFICER
Thekkady P.O., (Kerala) Telephone : KUMILY (04369)-22027

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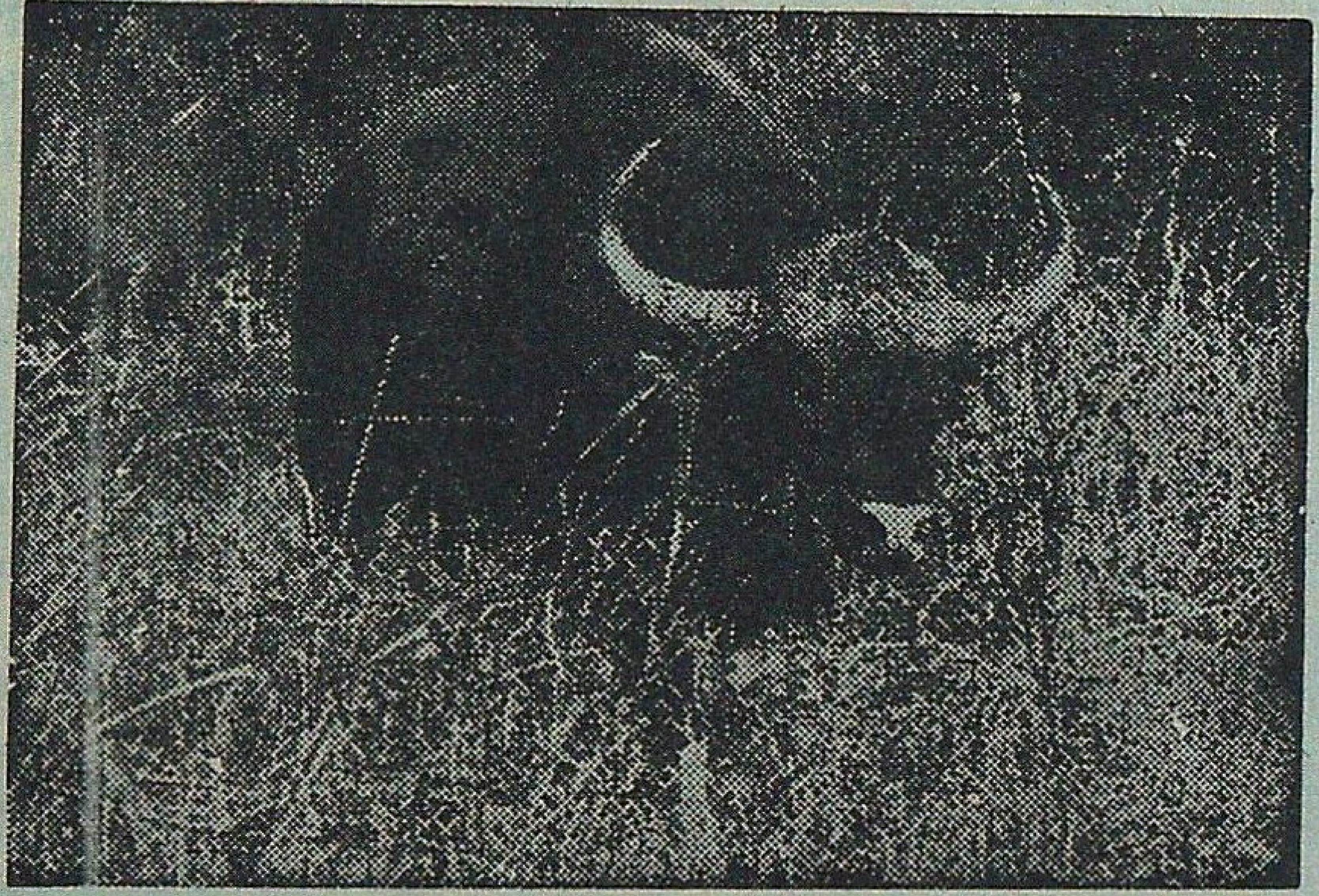

For further particulars write to :

THE FIELD DIRECTOR,
PROJECT TIGER
Palamau Tiger Reserve,
P.O. Daltonganj, Bihar (India)

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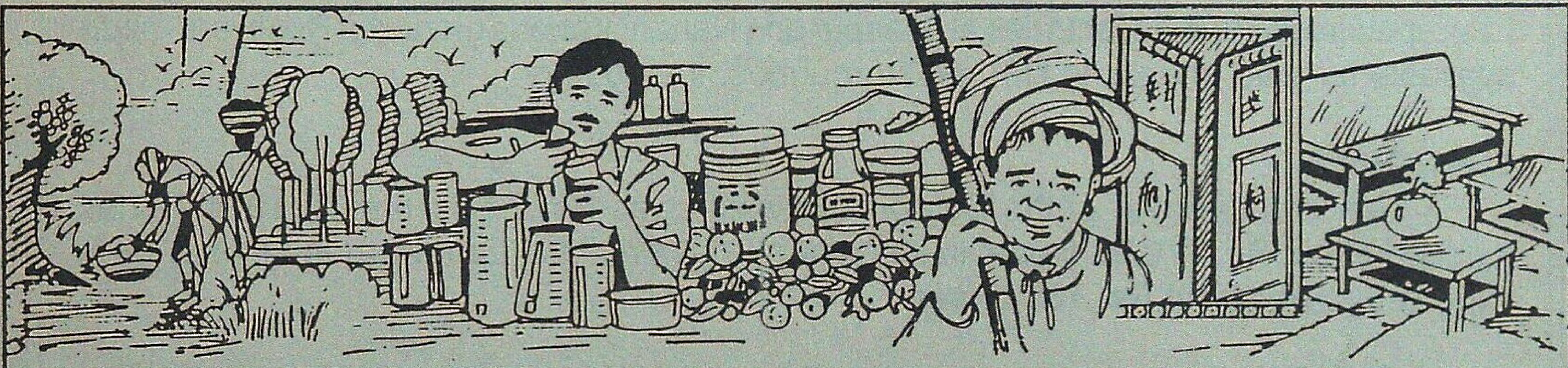

GSFDC - Taking up the challenge of tribal development

Gujarat State Forest Development Corporation Ltd. reaches out to tribals and the rural poor in the State through forest based trades and industries. Since inception in 1976, many developmental activities have been undertaken by us. A few of them are :

Minor Forest Products :

Collection, processing and marketing of over 55 economically important Minor Forest Products including Bidi Leaves, Non-Edible Oil Seeds, Mahuda Flowers, Gums, Honey, etc.

Medicinal Products :

Launching "DHANVANTARI PROJECT" for preparing value added herbal based medicines which has already brought 26 Ayurvedic preparations including Chyavanprash to the market.

Wood Products :

Wood Working Unit known as "VANIL UDYOG" in a tribal area where about 250 tribal artisans are provided sustained industrial employment and where facilities for seasoning and chemical treatment of timber have been created for manufacturing quality wooden products, such as, doors, windows, furnitures, etc.

Plantation Projects :

Managing the forest areas and plantations in Valsad district and Irrigated Plantation Project in Panchmahals district aimed at environmental improvement, production of timber, bamboos and firewood.

Other Welfare Activities :

Undertaking other tribal welfare activities, such as environment education, medical camps, seedling distribution etc.

Gujarat State Forest Development Corp. Ltd.

"Vanganga" 78, Alkapuri,
Vadodara - 390 005.
Phone No. : 312820 - 312821. Fax No. : 339232

MA MKT. & ADVT. BRO.

HIMACHAL PRADESH STATE FOREST CORPORATION LIMITED

Van Nigam Bhawan, SDA Complex, Kasumpti, Shimla - 171 009

(A Govt. of H.P. Undertaking)

H.P. State Forest Corporation in the Service of Himachal Pradesh

H.P. State Forest Corporation Limited was created in 1974 with the main objective to undertaking scientific working of timber and resin to eliminate Contractor's Agency.

TIMBER

Consequent upon the complete nationalization of Forest Working from 1983 onward, the Forest Corporation is converting and selling quality graded Deodar, Chil, Kail, Fir/Spruce timber obtained mainly from salvage marking (there being complete ban on green fellings) for domestic as well as commercial use. The requirement of timber of Govt. Department and Small Scale Industries in the Pradesh is also being fulfilled. Timber is sold mainly through auction from the main sale depots located at Parwanoo, Baddi, Bhadroya, Mantaruwala and Dhanotu. The Corporation also maintains timber depots at major cities and towns in H.P. for supply of timber to non-right-holders.

RESIN AND ROSIN

Resin tapping by 'Rill Method' was started in a phased manner from 1983-84 onwards, thereby resulting in enhanced yield and prevention of physical damage to standing Chil trees. The Corporation is producing quality Rosin and Turpentine oil as per I.S.I. specifications at its factories at Bilaspur and Nahan. Various grades of Rosin are made available for sale to units in H.P. and throughout the country.

TURNOVER

The total turnover of the Corporation which was Rs. 2.54 crores in 1974-75 has touched about Rs. 170.00 crores in the year 1997-98 and the turnover during 1998-99 is expected to be about Rs. 185 crores.

With the blessings of Shri Prem Kumar Dhumal, Hon'ble Chief Minister, Himachal Pradesh and under the able guidance of Shri Roop Singh Thakur, Hon'ble Forest Minister-cum-Chairman, the H.P. State Forest Corporation Limited is all set to achieve accelerated growth during the coming years.

(Gurmit Singh)
Managing Director

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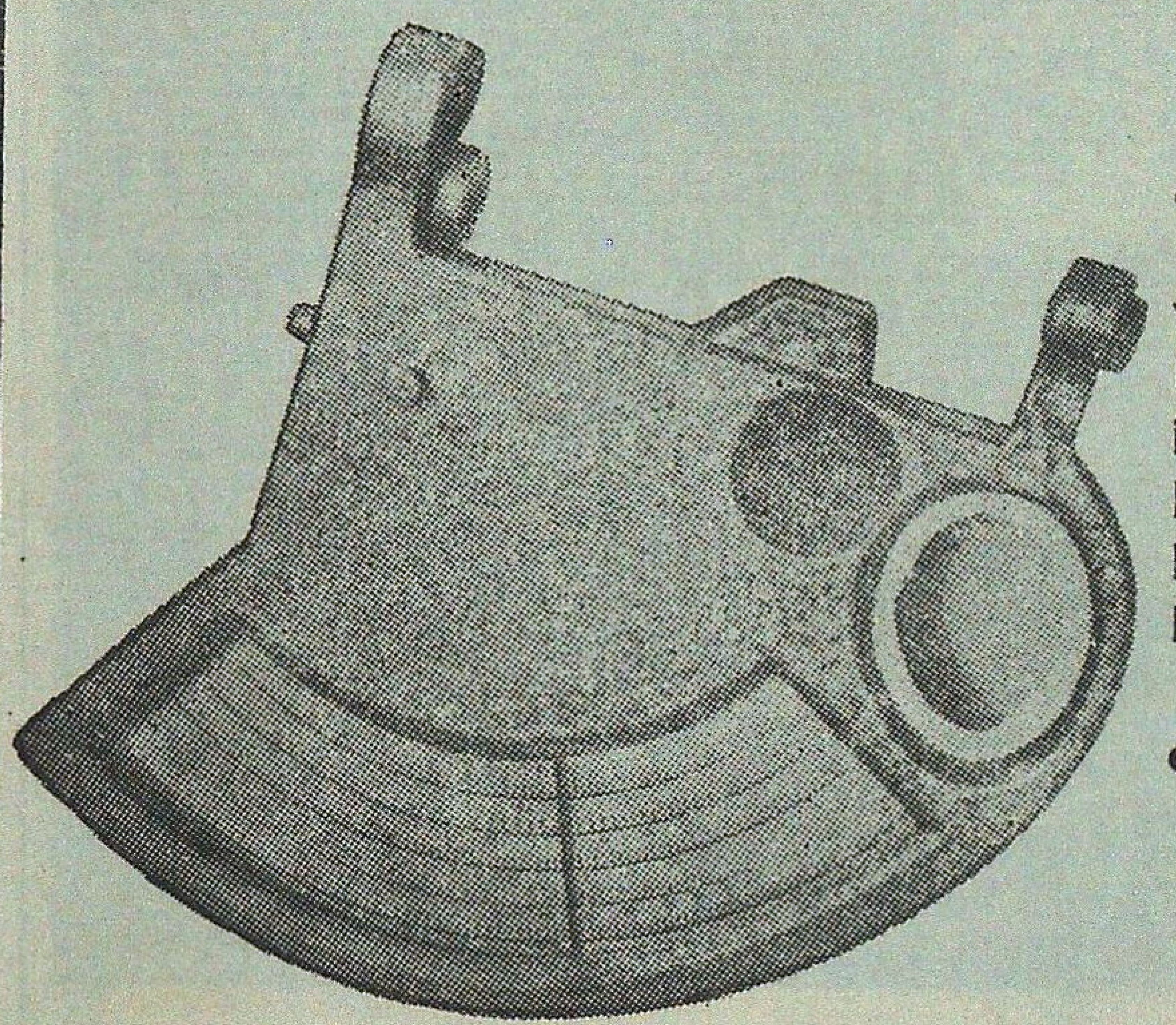

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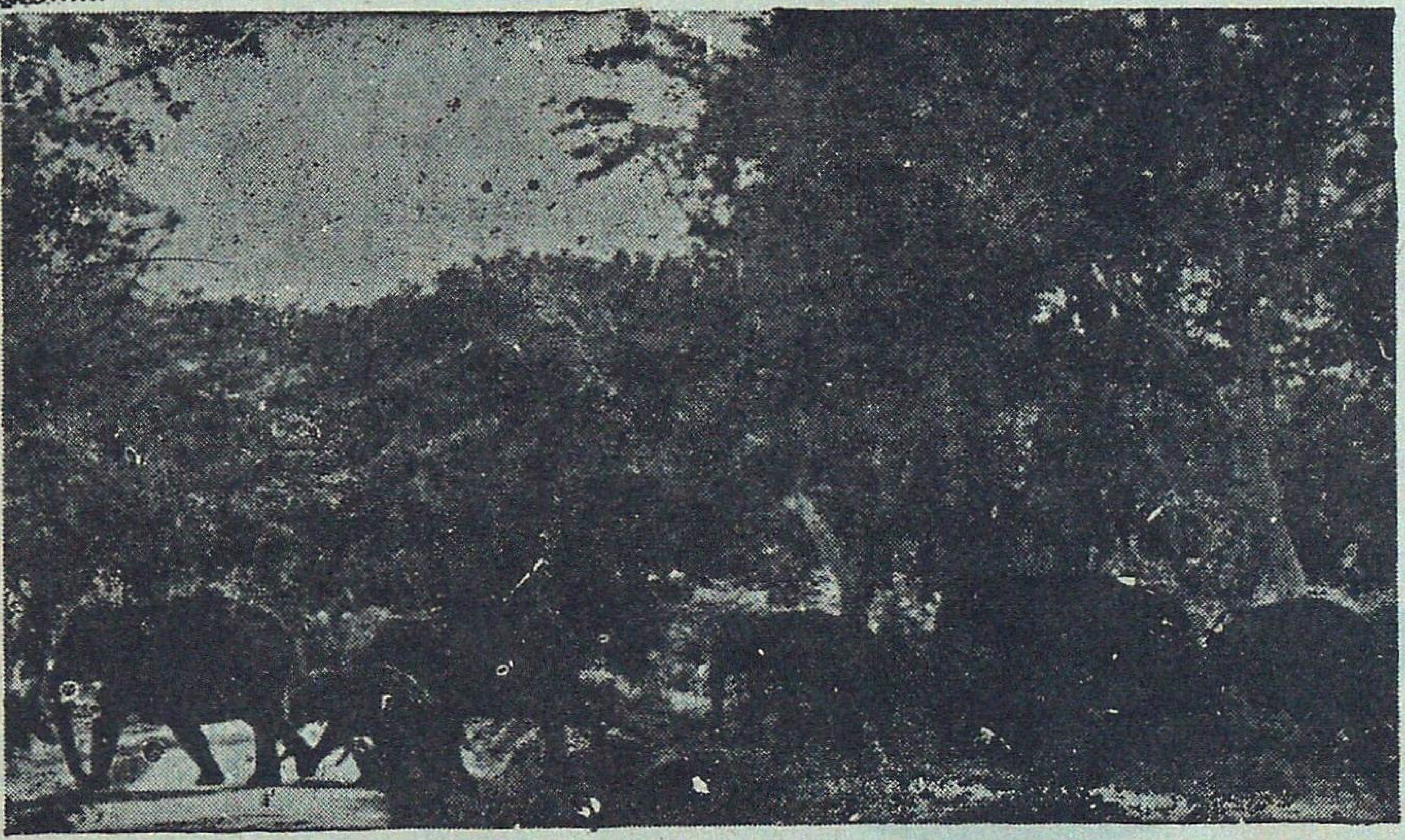

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